Potomac PCB TMDL

Current Status and Next Steps

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Technical Advisory Committee Meeting
Metropolitan Washington Council of Governments
Washington, DC

January 30, 2007

Challenges

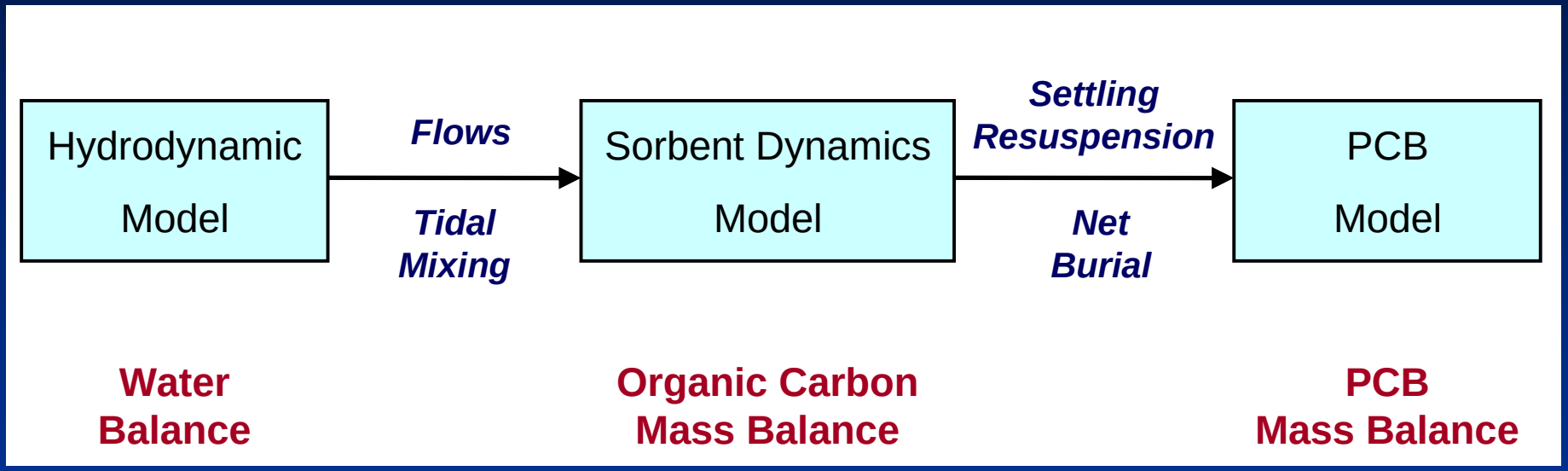
- Complexity of system
  - Tidal
  - Multiple PCB sources
    - Ongoing sources from watershed
    - Atmospheric sources
    - Legacy contamination in sediments
  - Different PCB water quality standards
    - DC, Maryland and Virginia
- PCB data limitations
  - Water column
  - Loadings
- Ambitious schedule
  - Court mandates
  - Administrative agreements

Modeling Schedule

- Final Calibration and Validation
  - February 23, 2007
- Draft Report on Hydrodynamic, Salinity and PCB Mass Balance Models
  - April 1, 2007
- Final Modeling Report
  - June 1, 2007

Modeling Approach

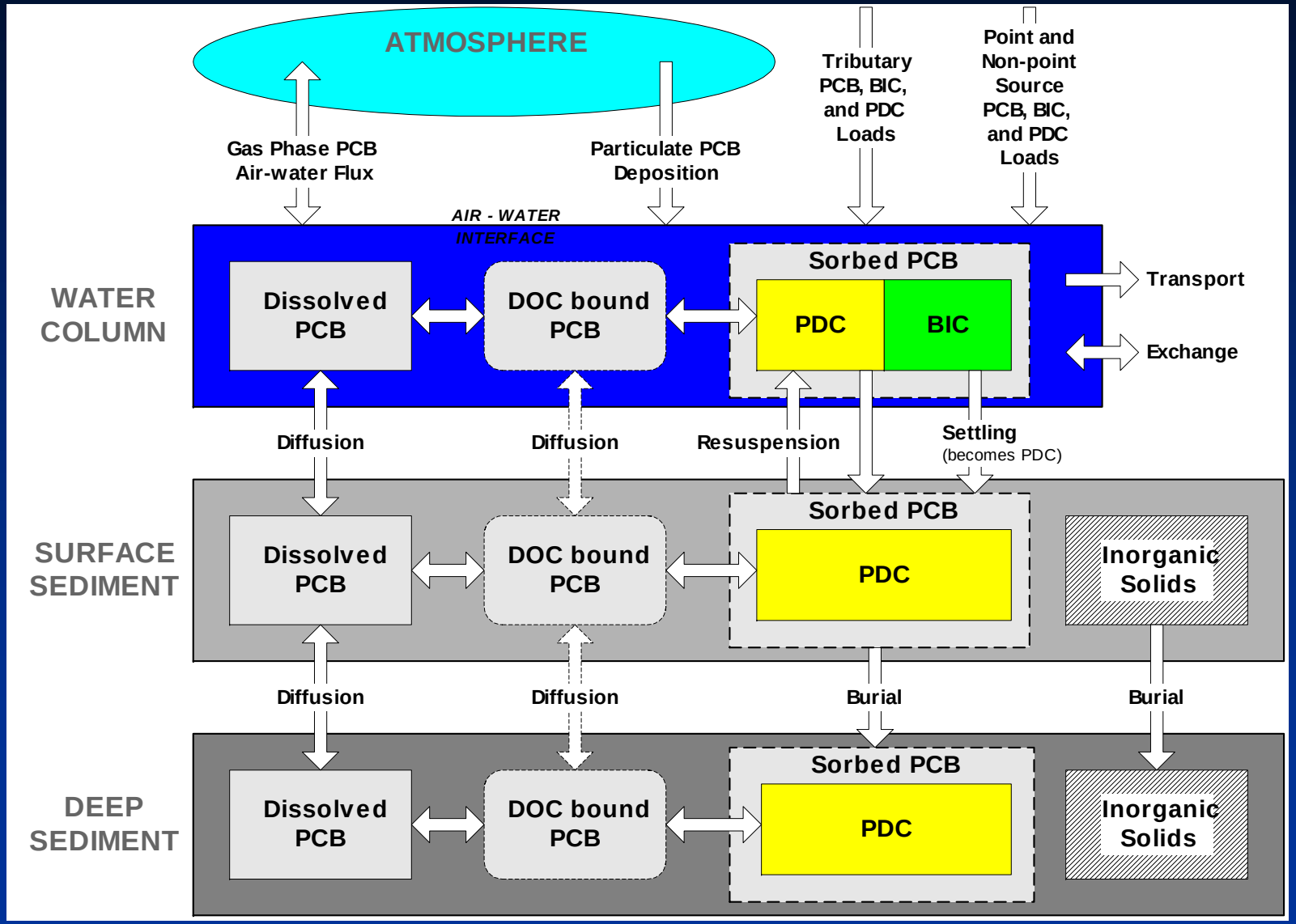
Integrated Modeling Framework



Key Features

- Hydrodynamics (DYNHYD5)
  - Builds upon CBEMP, TAM/WASP and DEM models
  - 1D branched spatial grid
  - Represents main channel, Anacostia and Virginia embayments
  - Daily forcing for freshwater inflows
  - Hourly forcing for downstream tidal heights
- PCB Mass Balance (WASP5)
  - PCBs follow the organic carbon
  - Builds upon Delaware River Estuary PCB TMDL model
  - 1:1 spatial mapping between DYNHYD5 and WASP5
  - 2D horizontal spatial grid
  - 250 spatial grid cells

DELPCB Model Framework



Principal Model Limitations

Does Not Represent ….

- Lateral spatial gradients within main channel and/or within embayments, tributaries and coves
- Potential differences in sediment-water exchanges between the main channel and nearshore areas
- Complex physical processes in the vicinity of the estuarine turbidity maximum
- Vertical stratification in the lower estuary
- Sediment transport or suspended solids mass balance

Model Grid Development

- Chesapeake Bay Model (57K grid)
  - Mainstem Potomac
  - Middle and lower estuary
- TAM/WASP Model
  - Anacostia
- Dynamic Estuary Model (DEM)
  - Washington Ship Channel
- VIMS Virginia Embayment Models
  - Virginia embayments

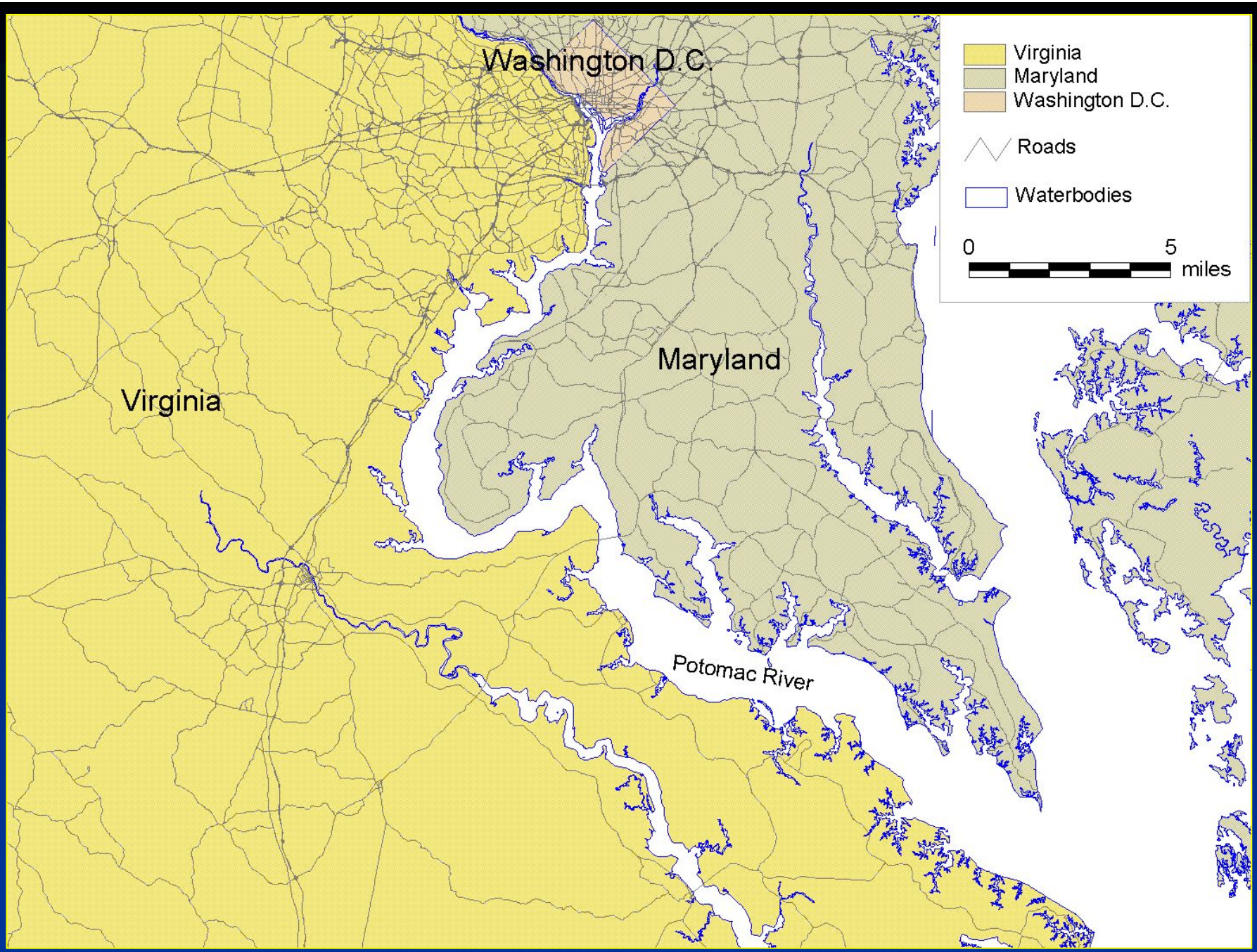


Figure 1. Map of Study Area

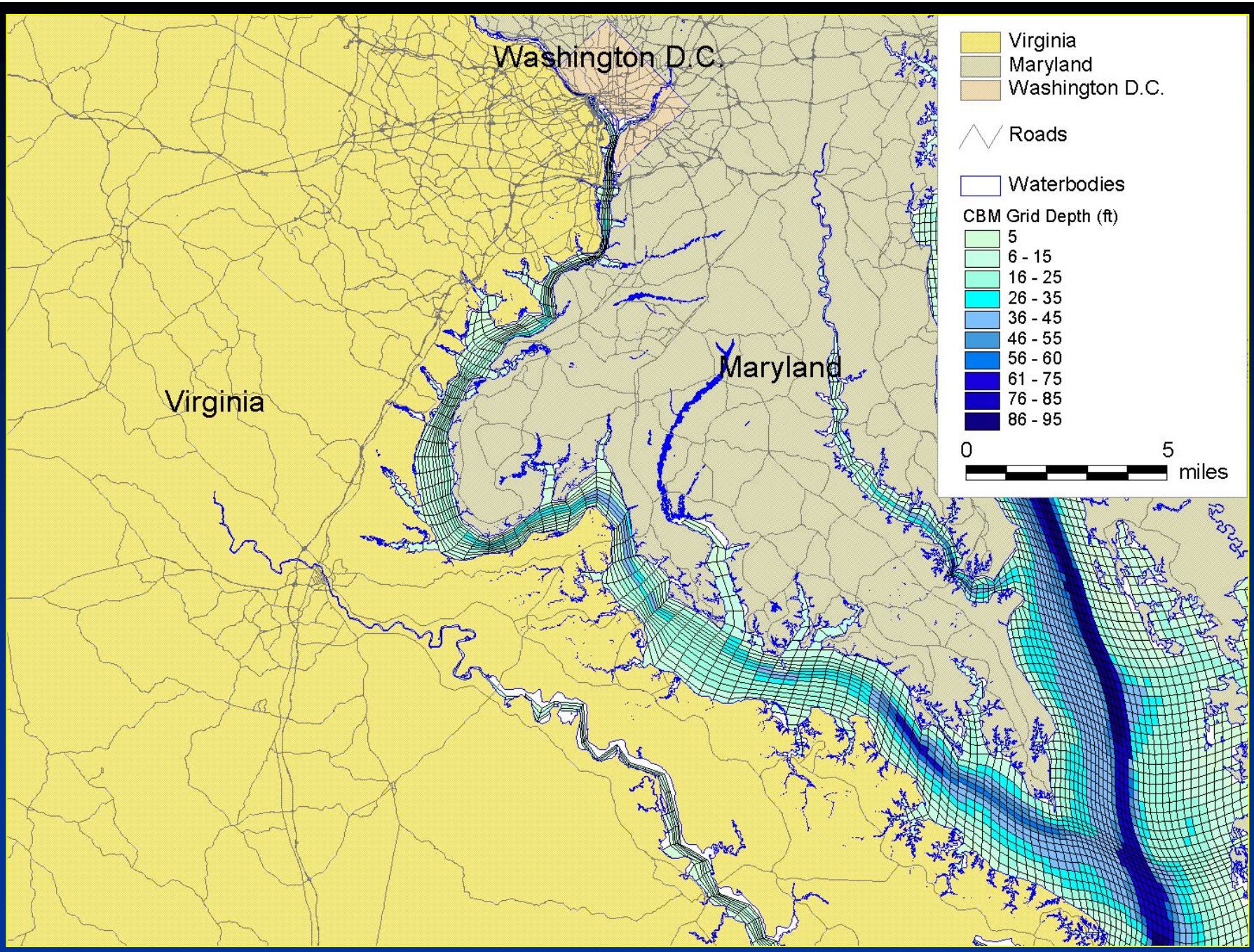


Figure 2. Bathymetry from 57K Chesapeake Bay Environmental Model Package (CBEMP)

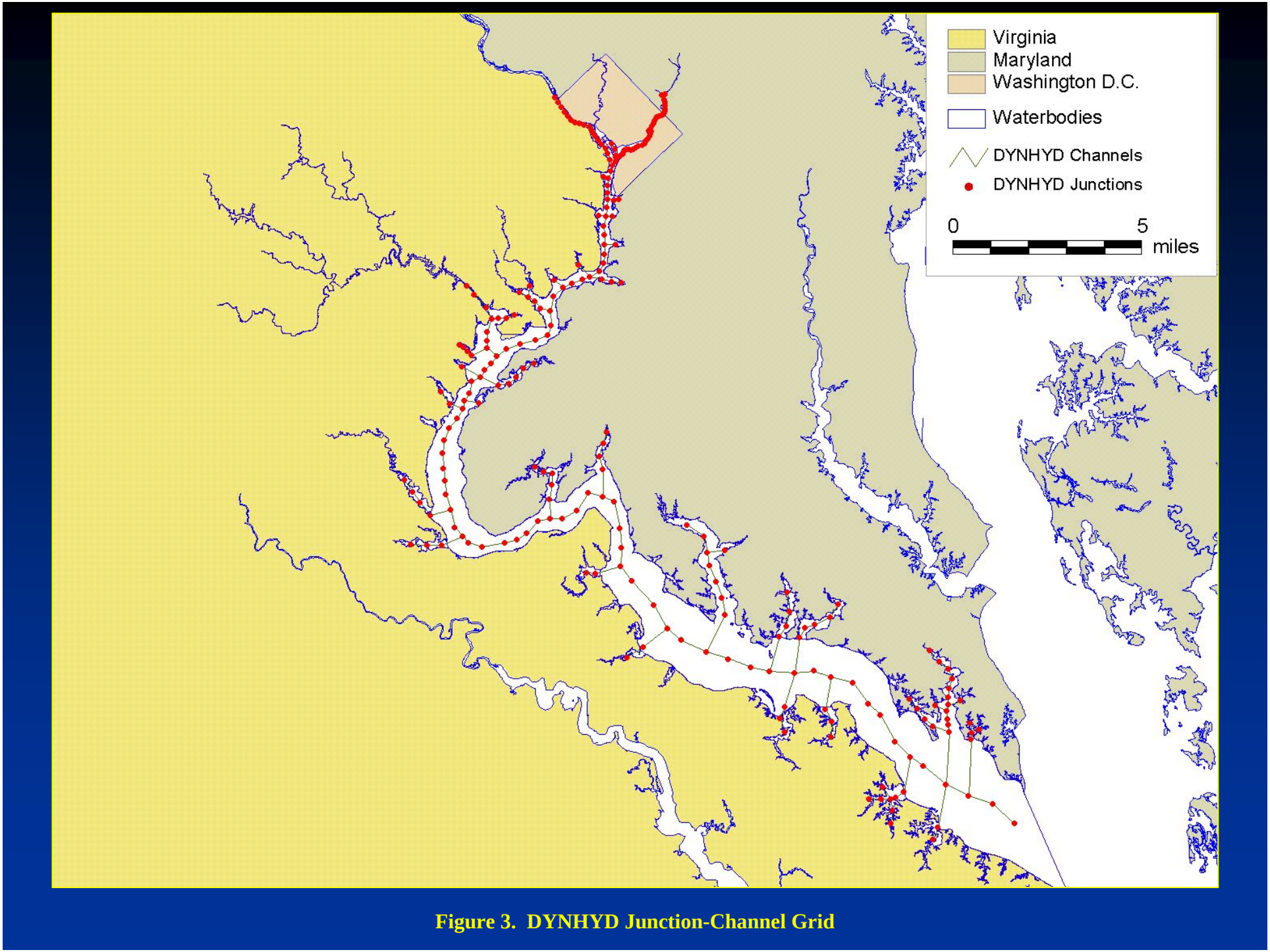


Figure 3. DYNHYD Junction-Channel Grid

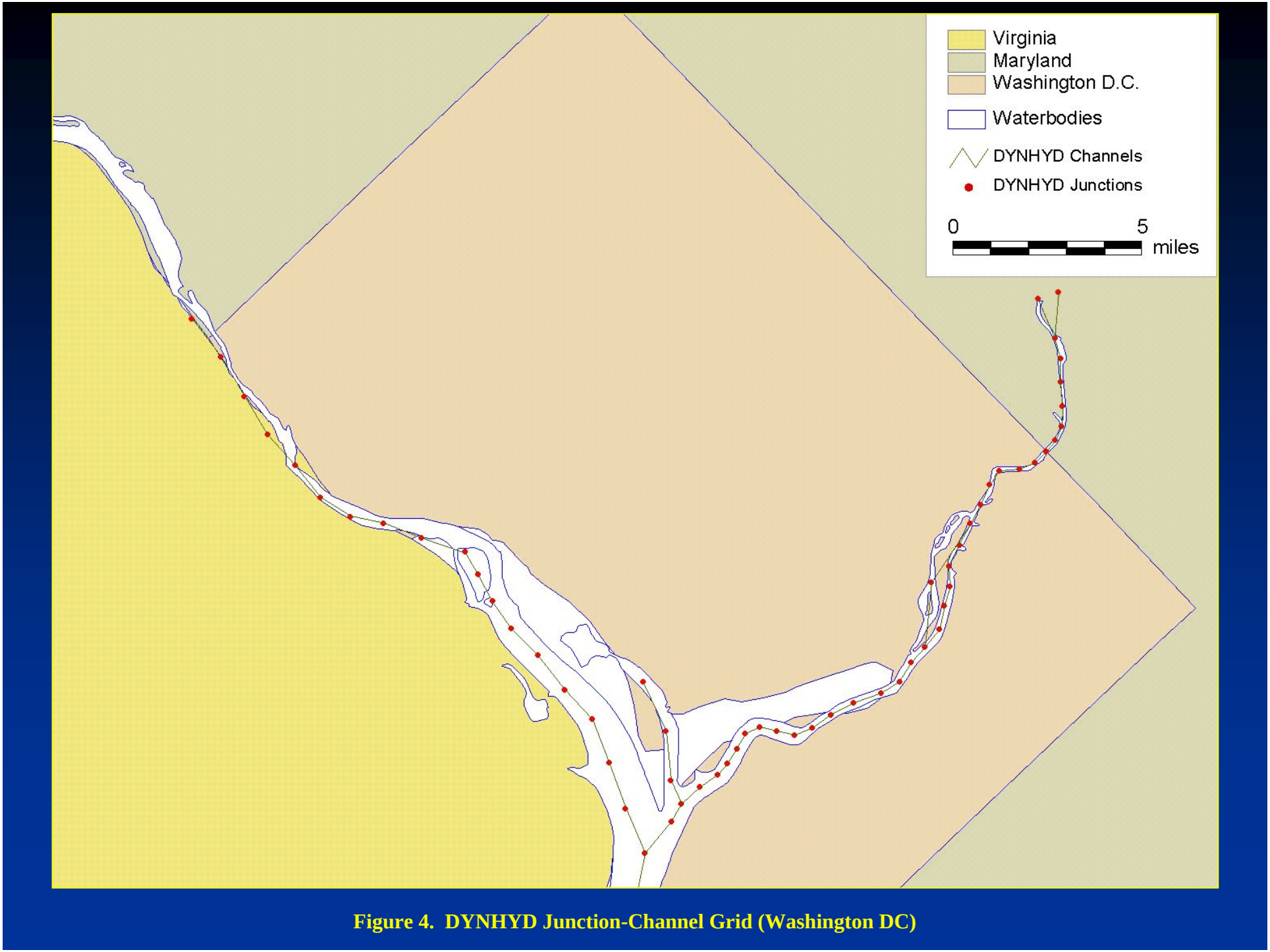


Figure 4. DYNHYD Junction-Channel Grid (Washington DC)

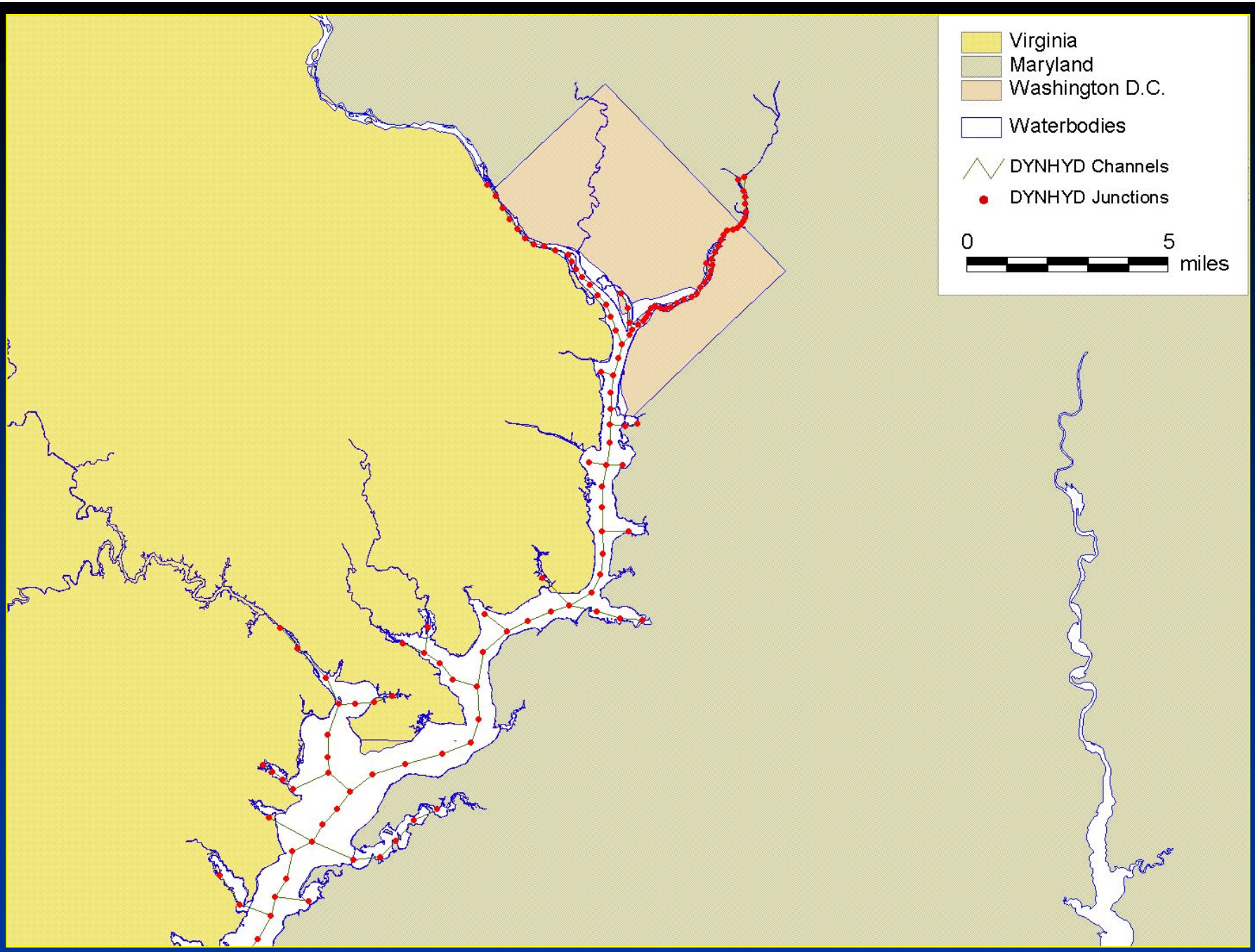


Figure 5. DYNHYD Junction-Channel Grid (Upper Potomac)

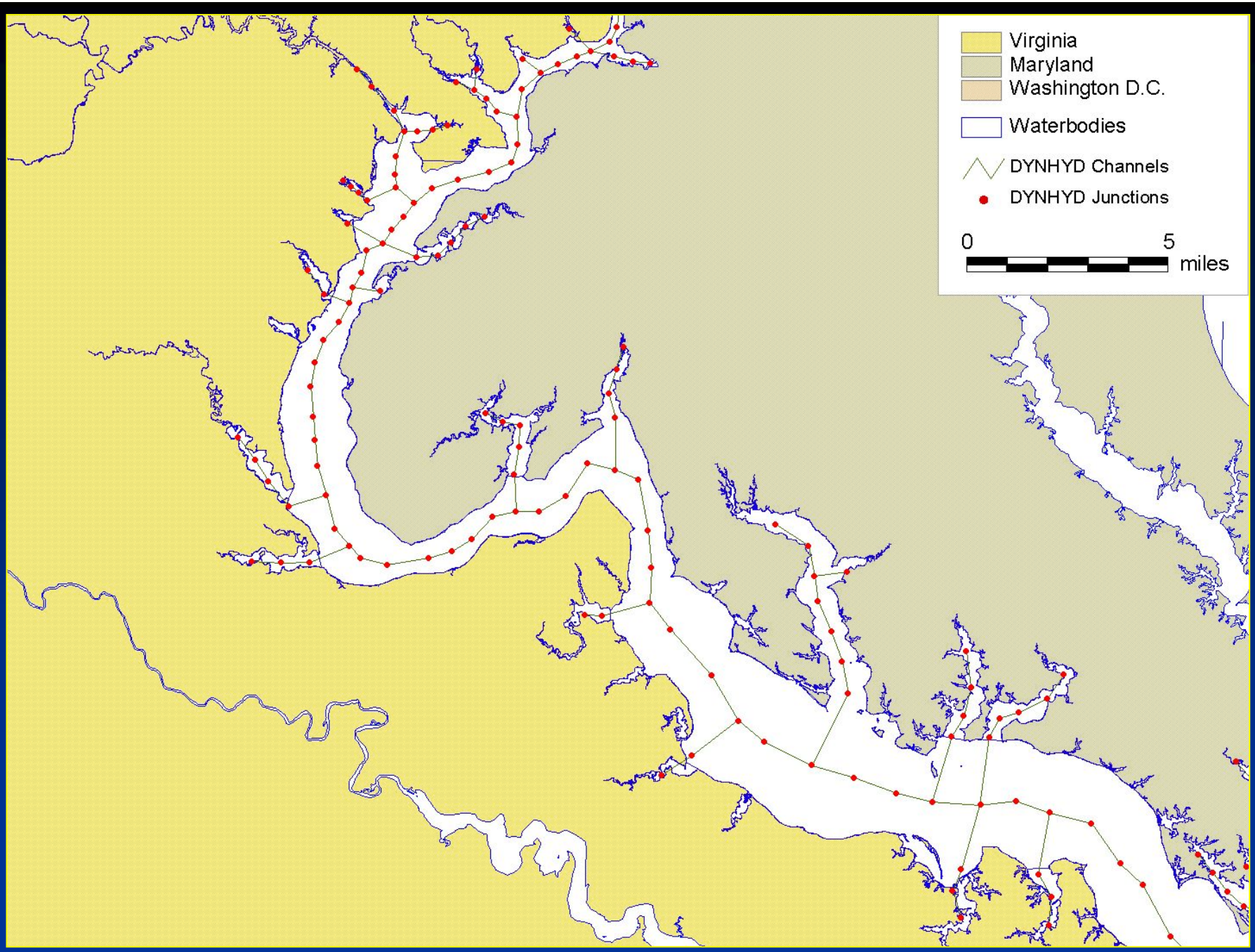


Figure 6. DYNHYD Junction-Channel Grid (Middle Potomac)

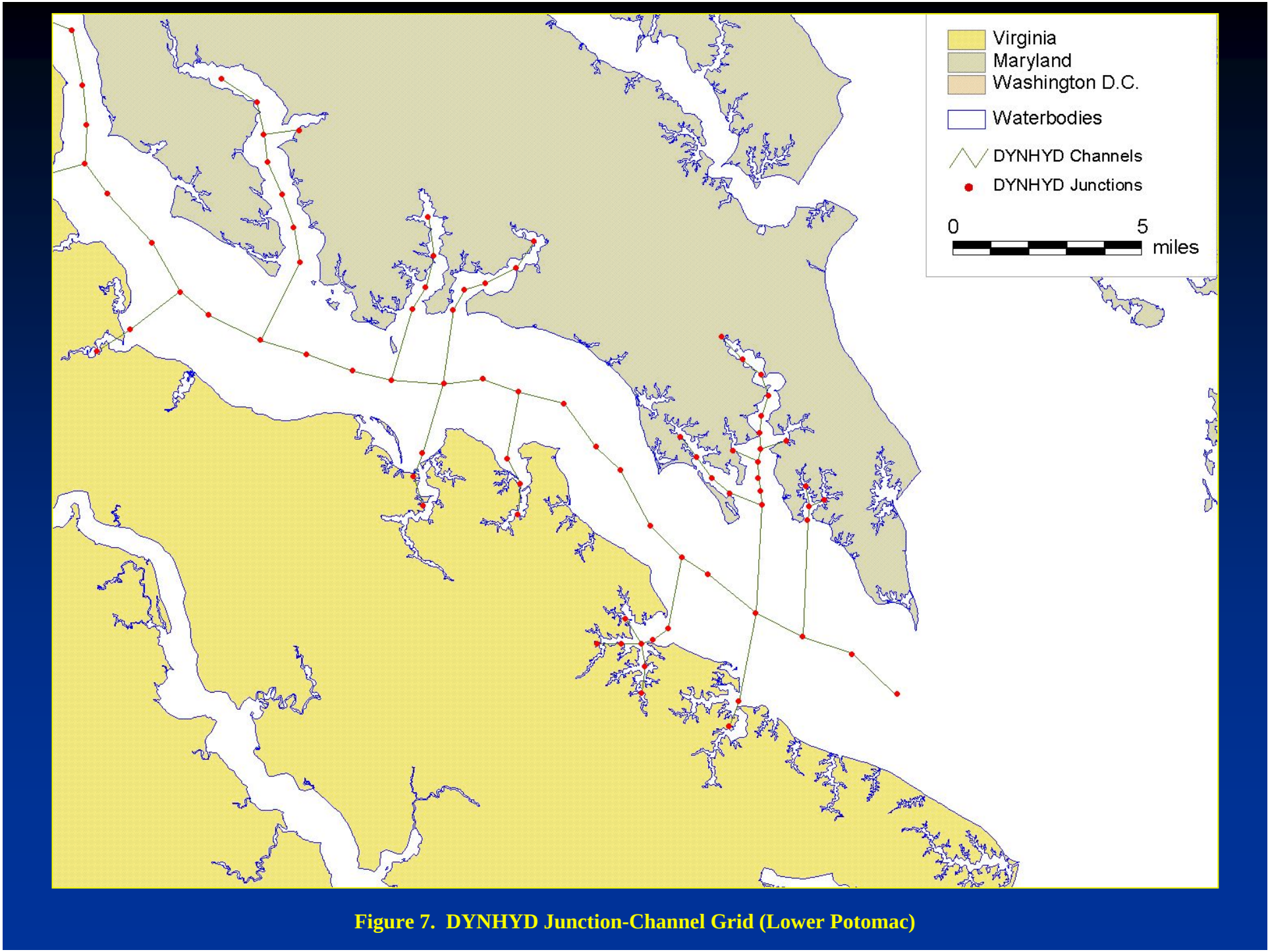
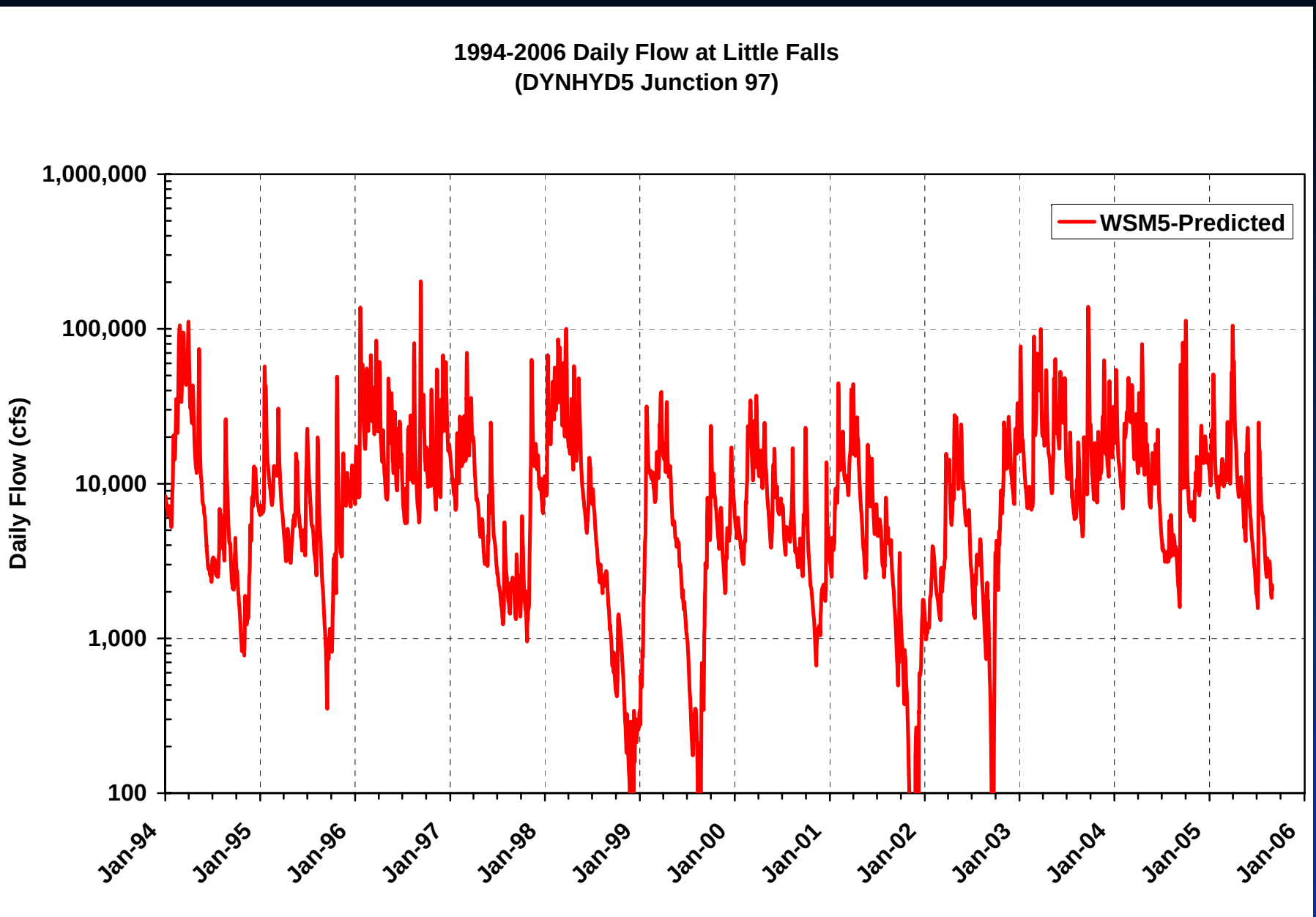


Figure 7. DYNHYD Junction-Channel Grid (Lower Potomac)


1994-2006 Daily Flow at Little Falls
(DYNHYD5 Junction 97)
Daily Flow (cfs)
1,000,000
100,000
10,000
1,000
100
WSM5-Predicted
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06

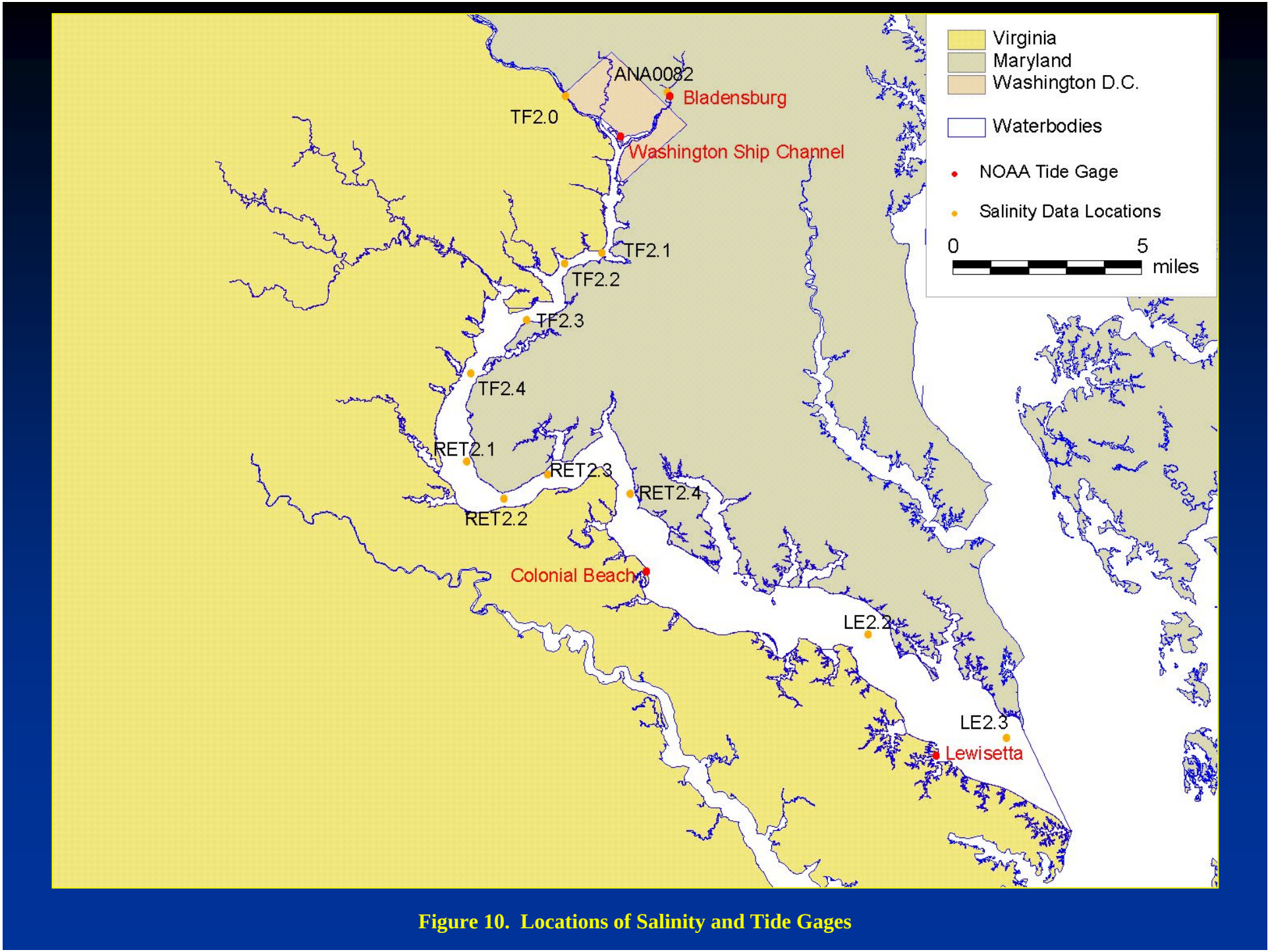
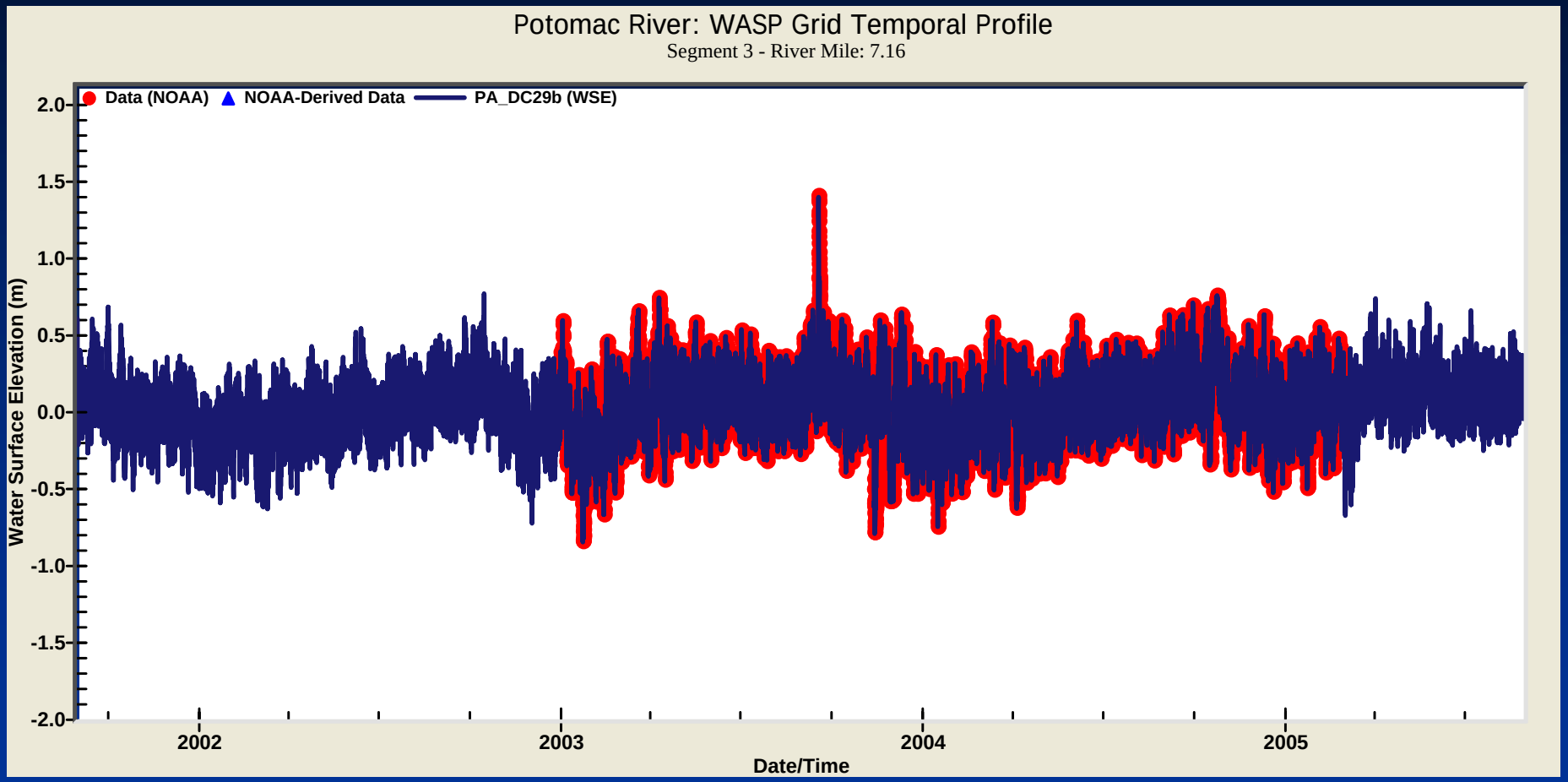


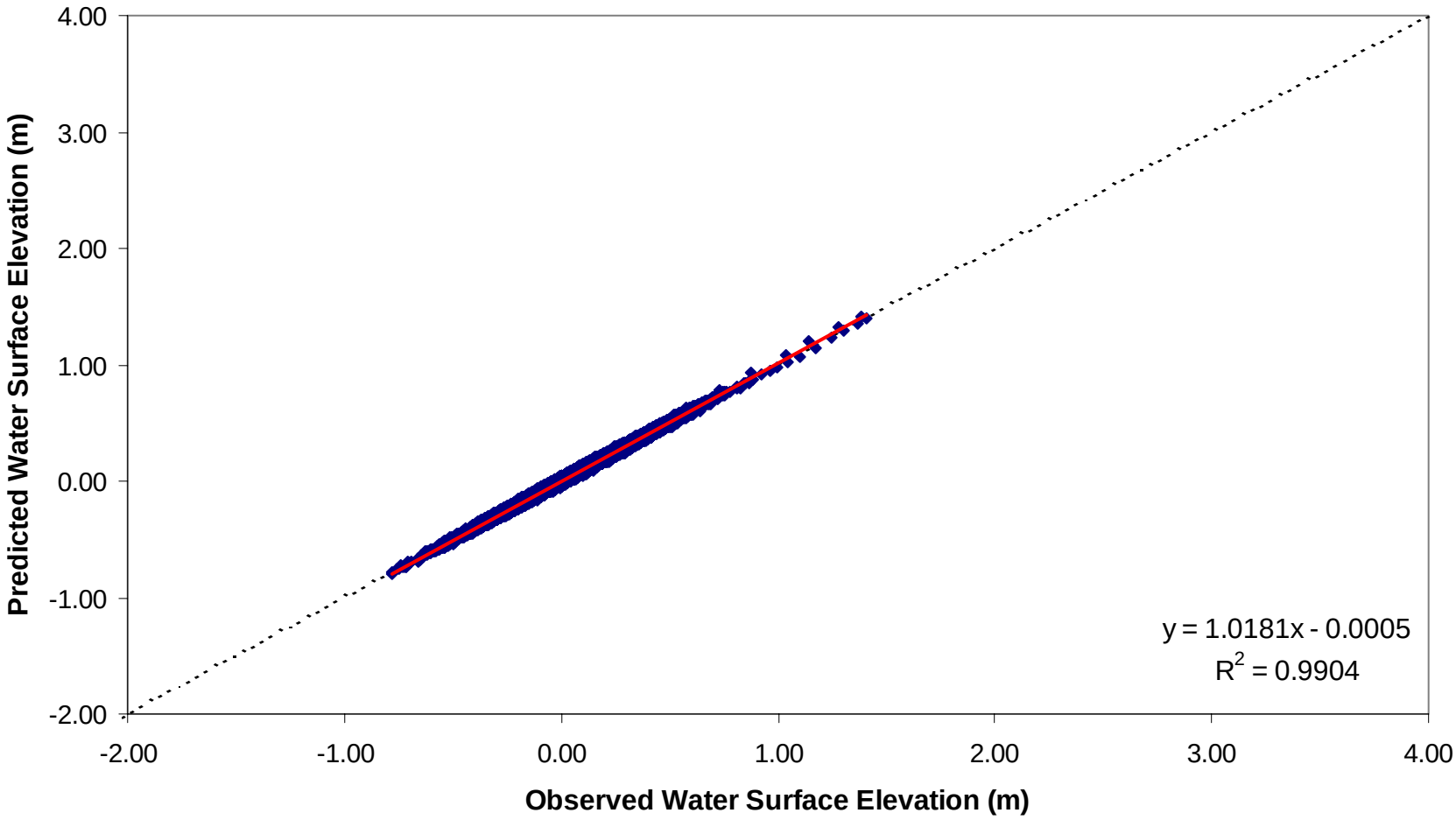
Figure 10. Locations of Salinity and Tide Gages

Hydrodynamic Model

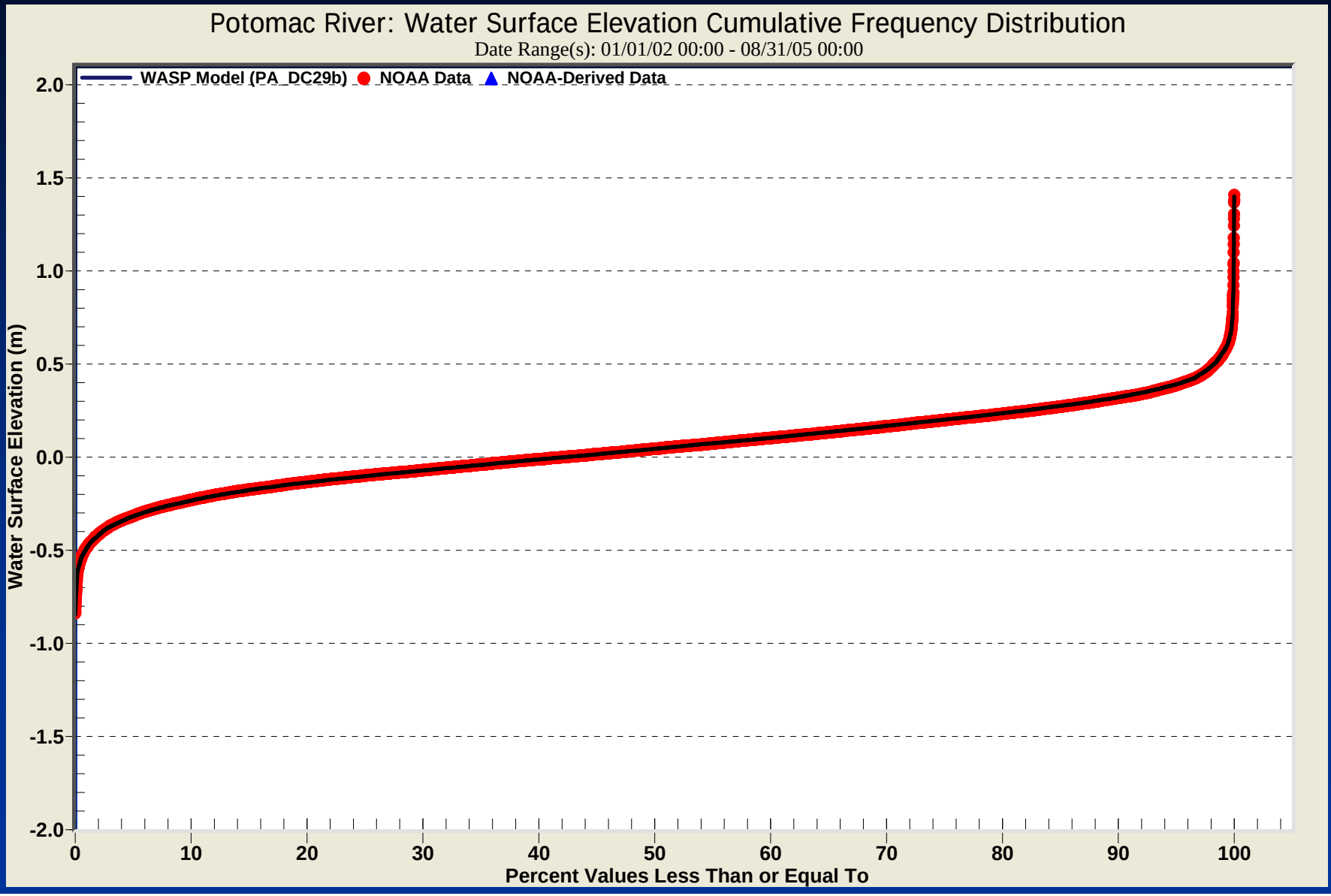
Water Surface Elevation

Lewisetta

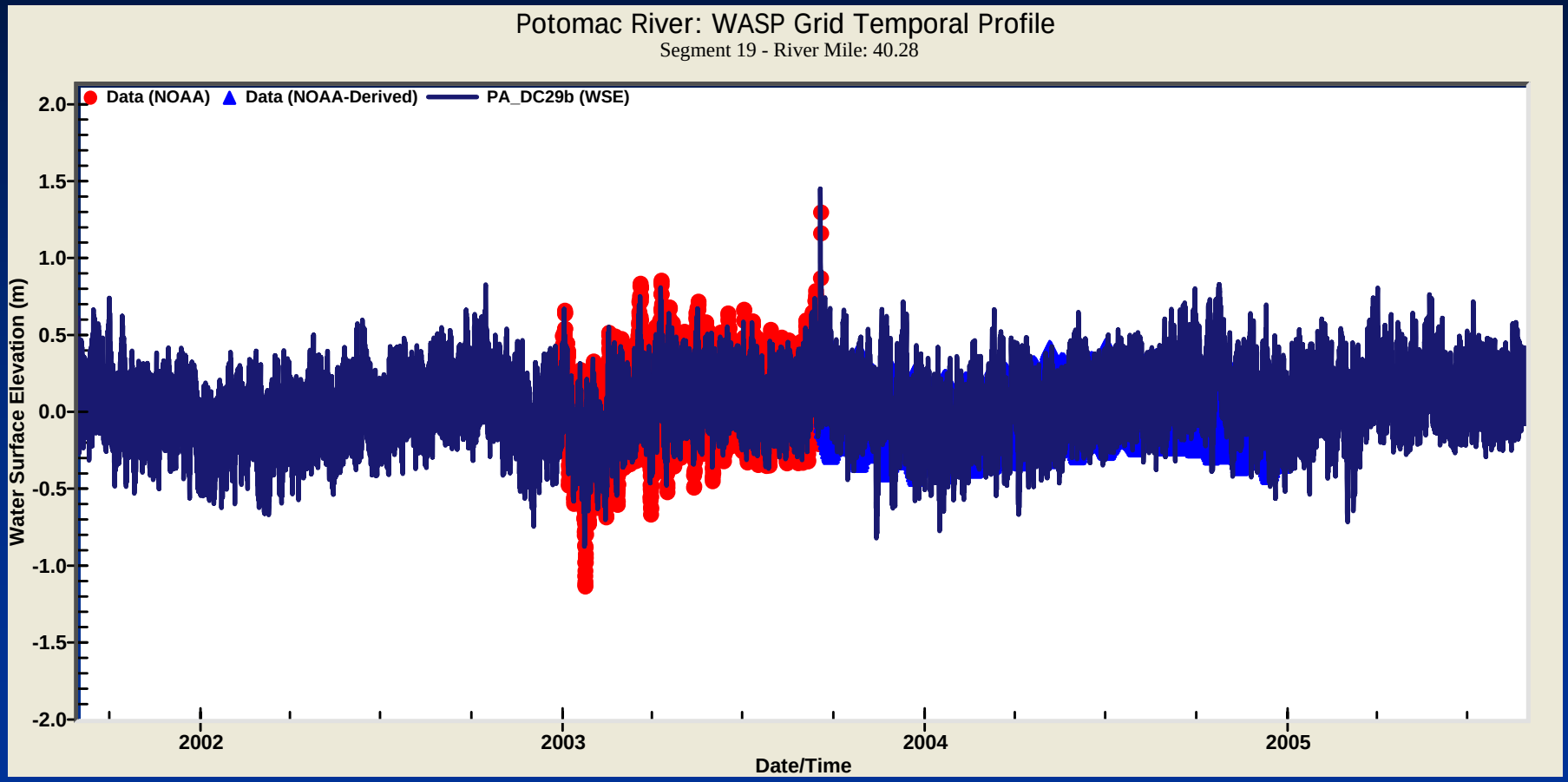

Potomac River: WASP Grid Temporal Profile
Segment 3 - River Mile: 7.16
Data (NOAA)
NOAA-Derived Data
PA_DC29b (WSE)
Water Surface Elevation (m)
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
2002
2003
2004
2005
Date/Time

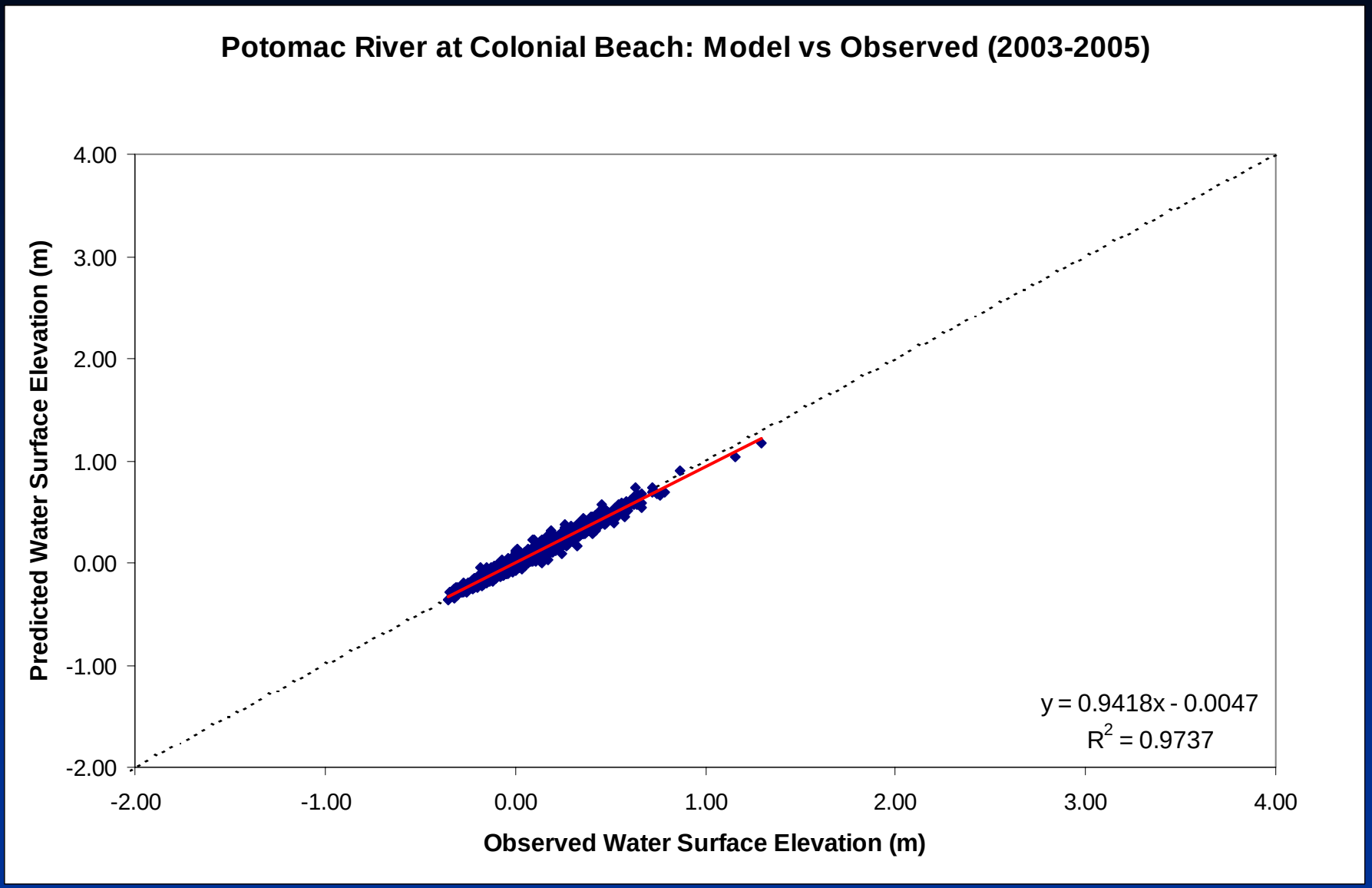

Potomac River at Lewisetta : Model vs Observed (2003-2005)
Predicted Water Surface Elevation (m)
Observed Water Surface Elevation (m)
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
y = 1.0181x - 0.0005
R2 = 0.9904

Lewisetta

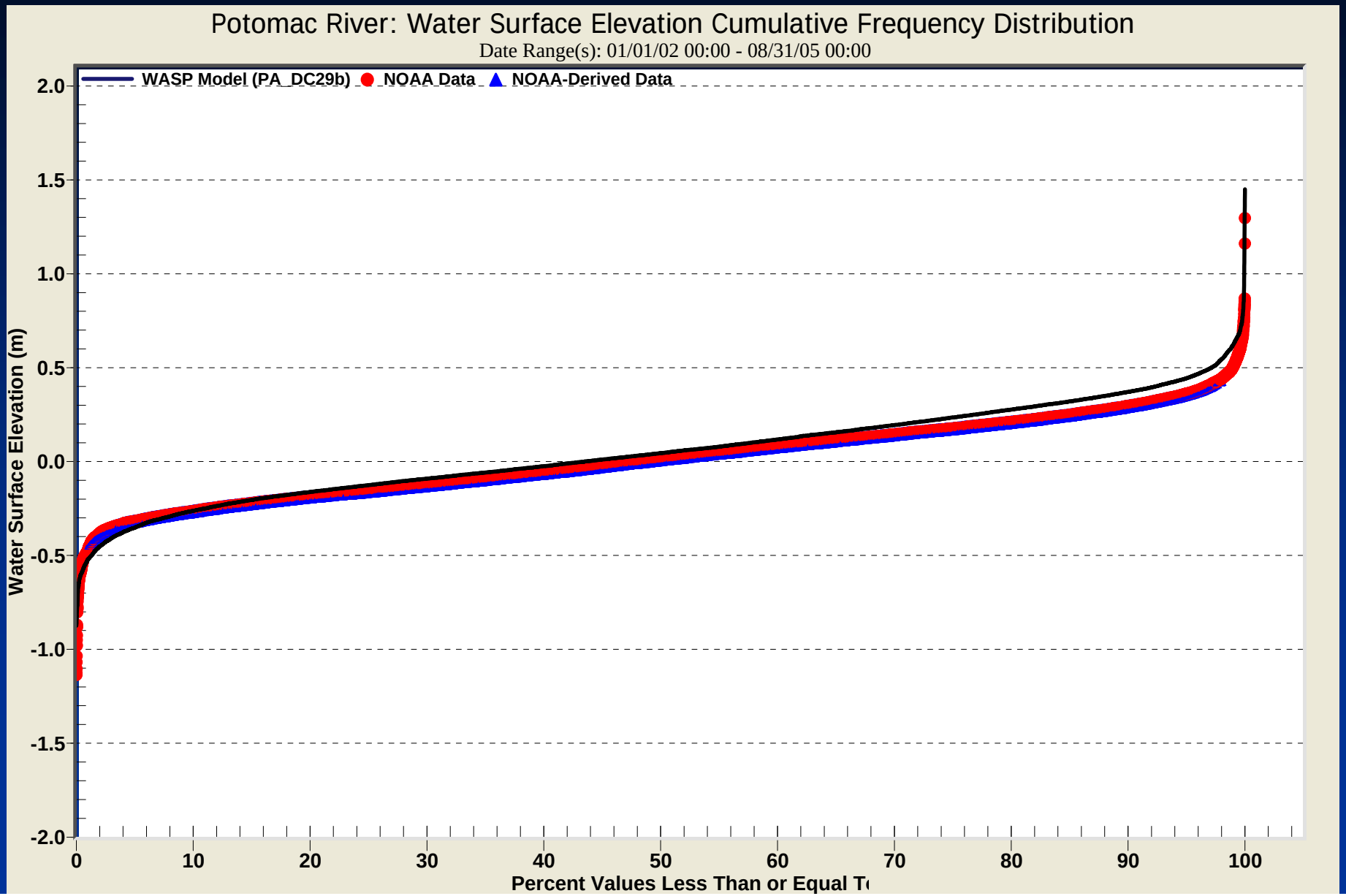

Potomac River: Water Surface Elevation Cumulative Frequency Distribution
Date Range(s): 01/01/02 00:00 - 08/31/05 00:00
WASP Model (PA_DC29b)
NOAA Data
NOAA-Derived Data
Water Surface Elevation (m)
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
0
10
20
30
40
50
60
70
80
90
100
Percent Values Less Than or Equal To

Colonial Beach

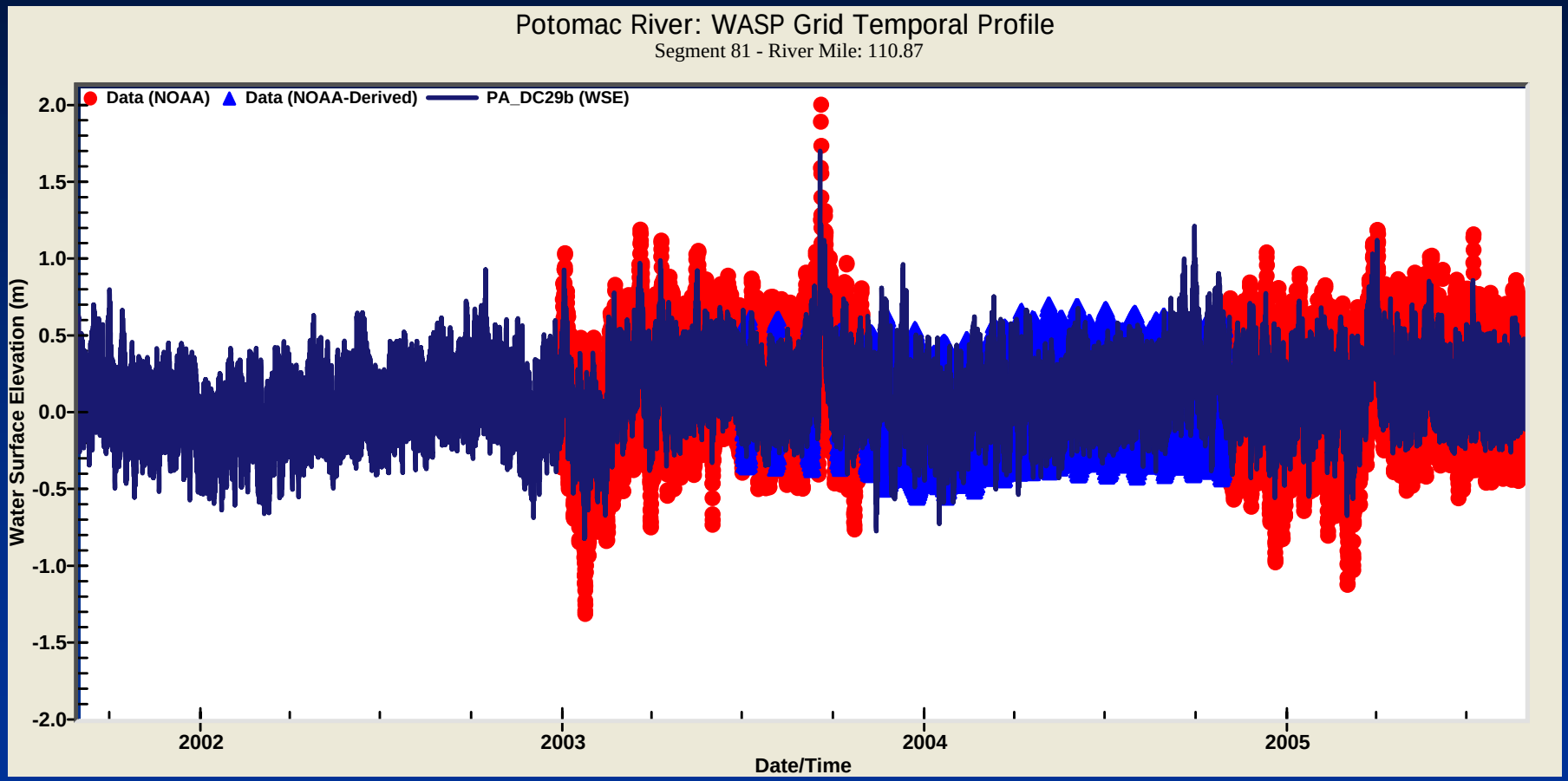


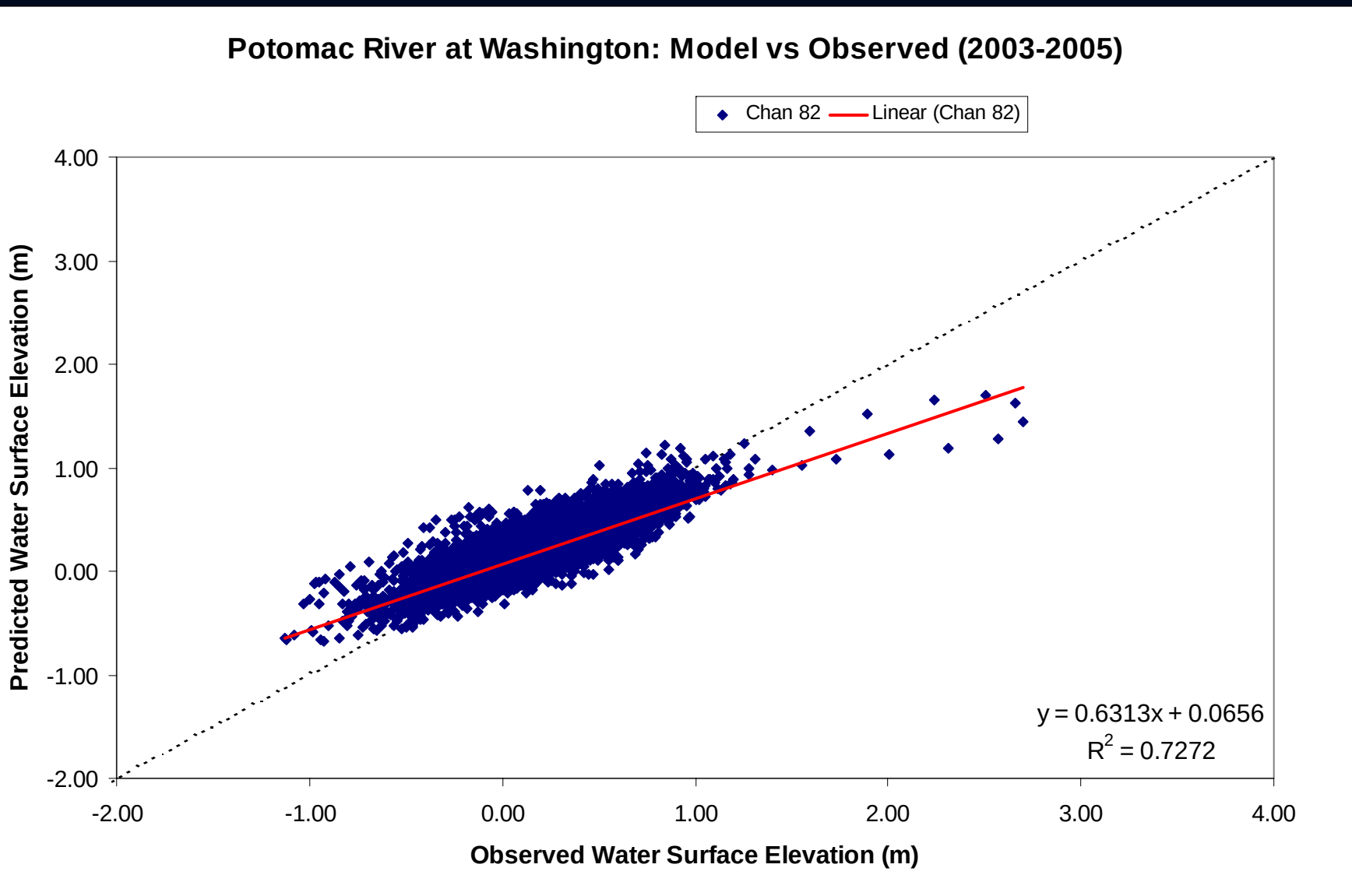

Potomac River at Colonial Beach: Model vs Observed (2003-2005)
Predicted Water Surface Elevation (m)
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
Observed Water Surface Elevation (m)
y = 0.9418x - 0.0047
R2 = 0.9737

Colonial Beach

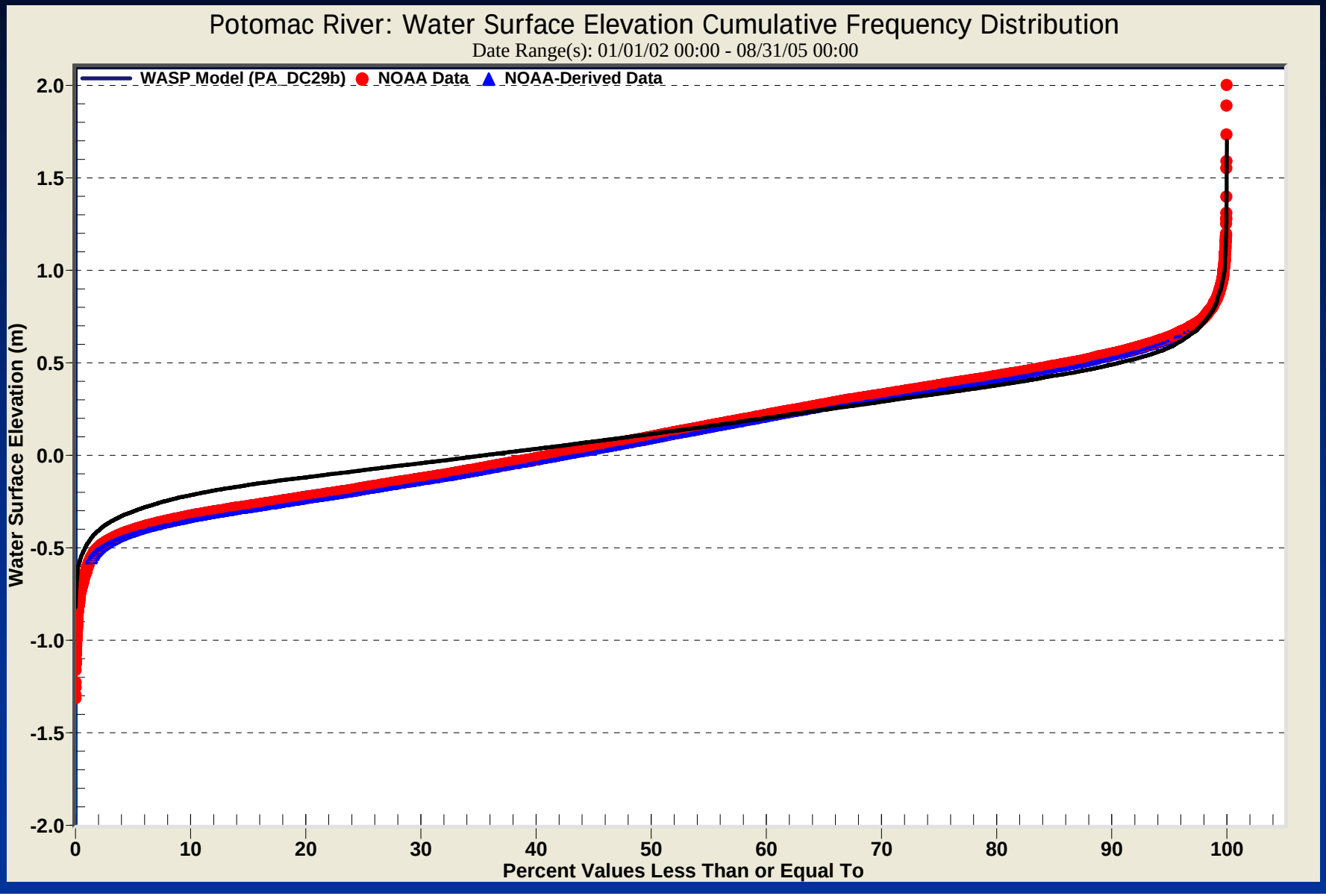


Washington, DC




Potomac River at Washington: Model vs Observed (2003-2005)
Chan 82
Linear (Chan 82)
Predicted Water Surface Elevation (m)
Observed Water Surface Elevation (m)
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
y = 0.6313x + 0.0656
R2 = 0.7272

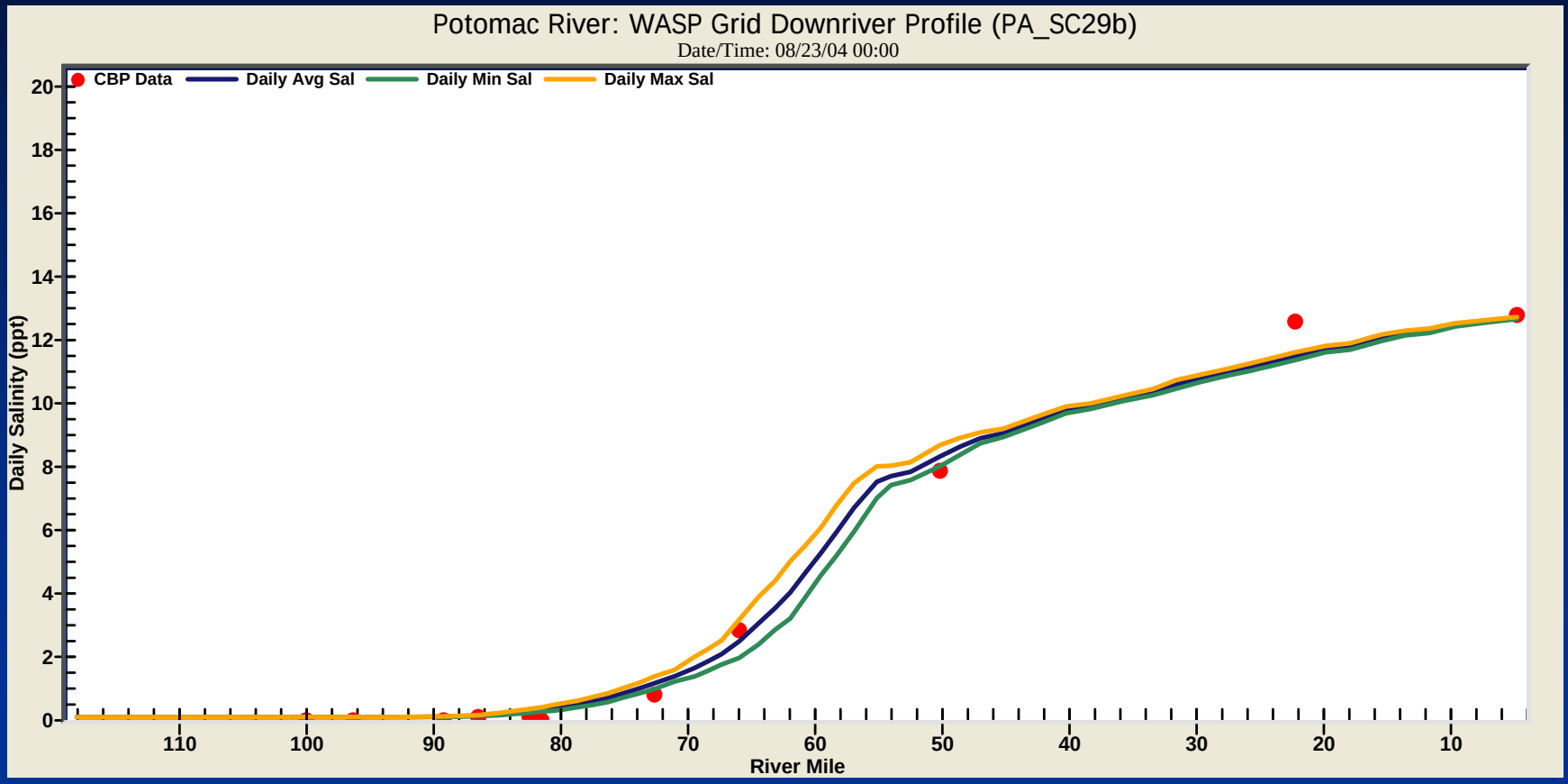
Washington, DC



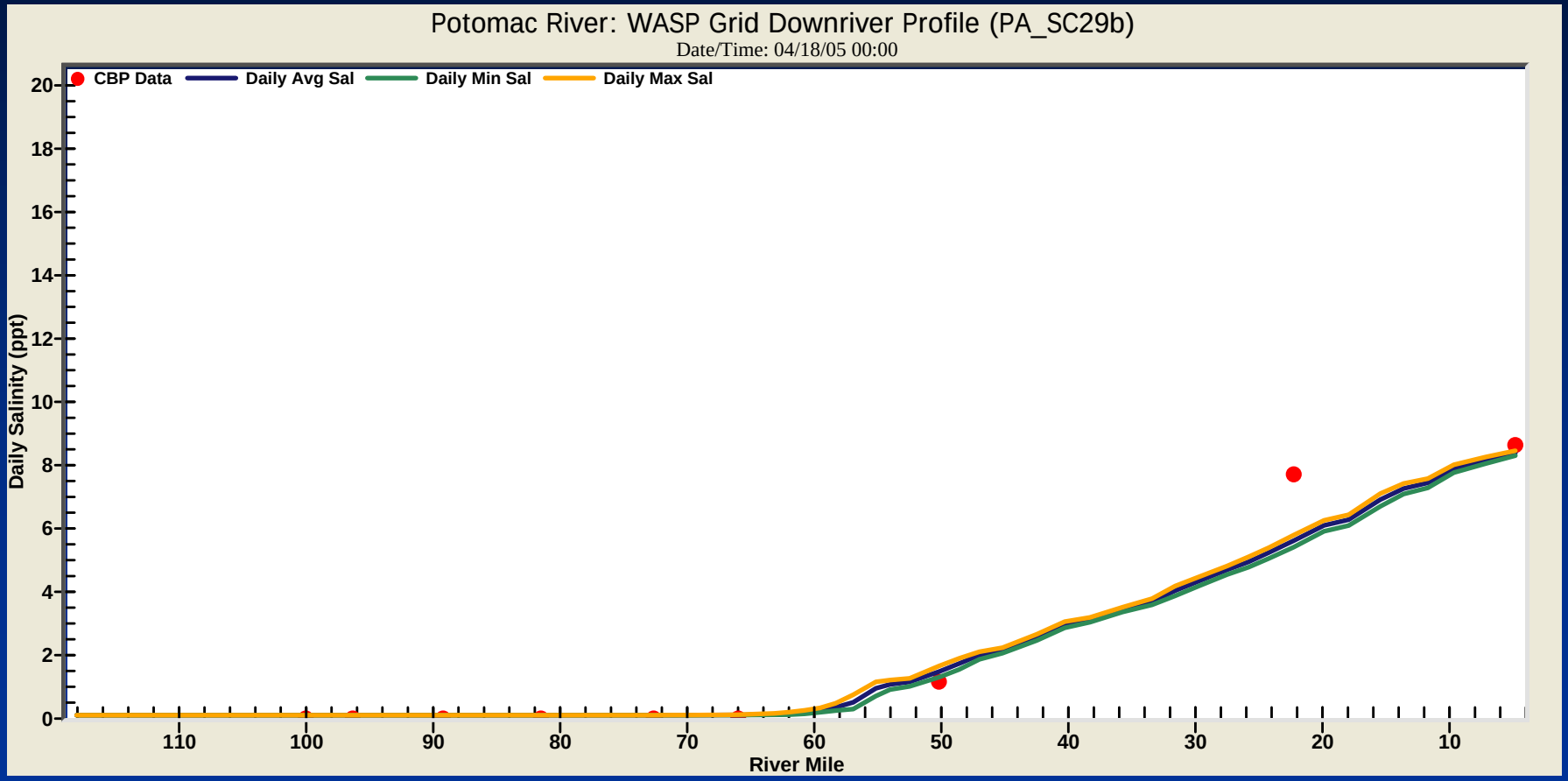
Mass Balance Model

Salinity

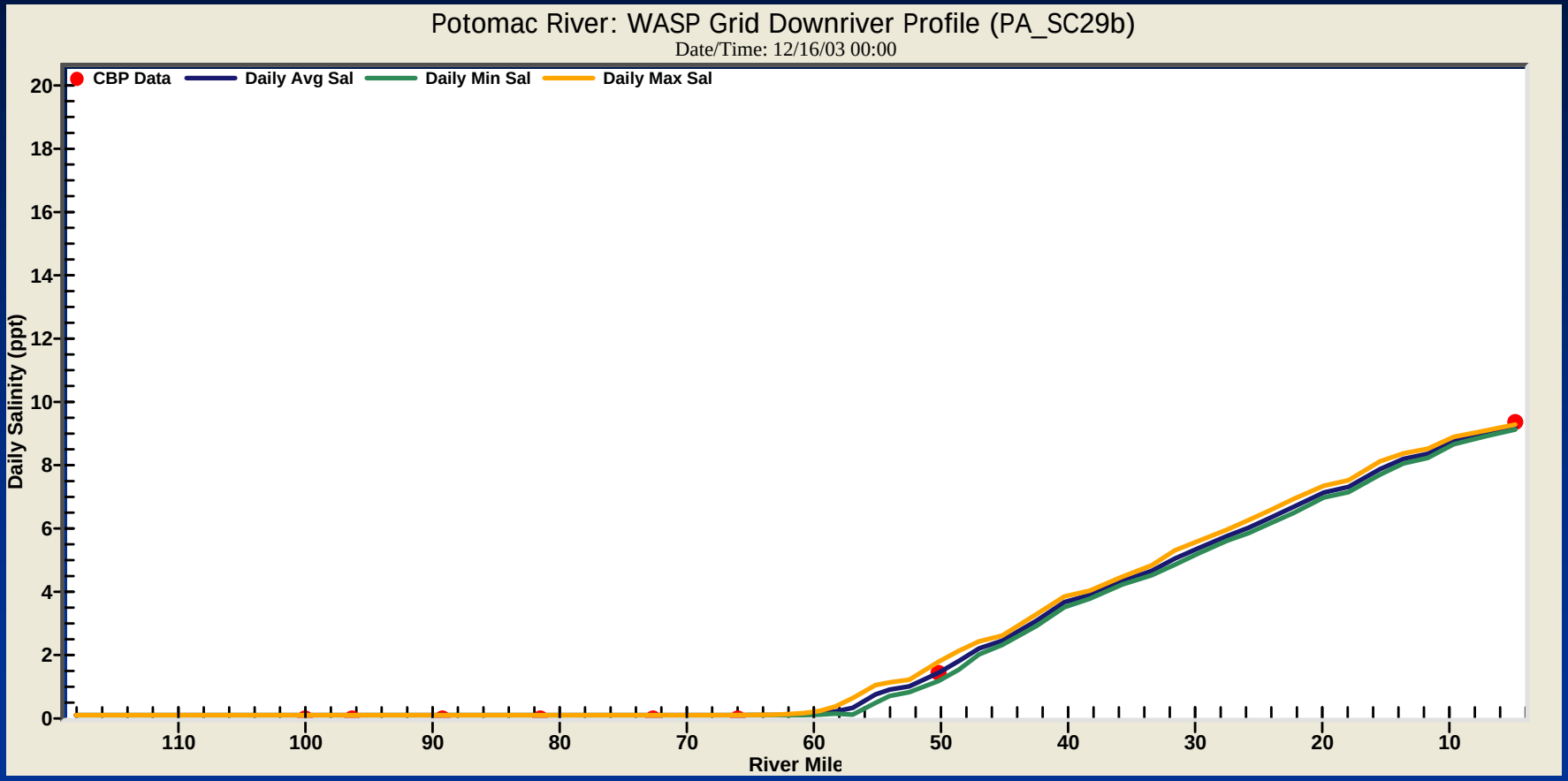
Low Flow – 3,729 cfs
(20th Percentile)

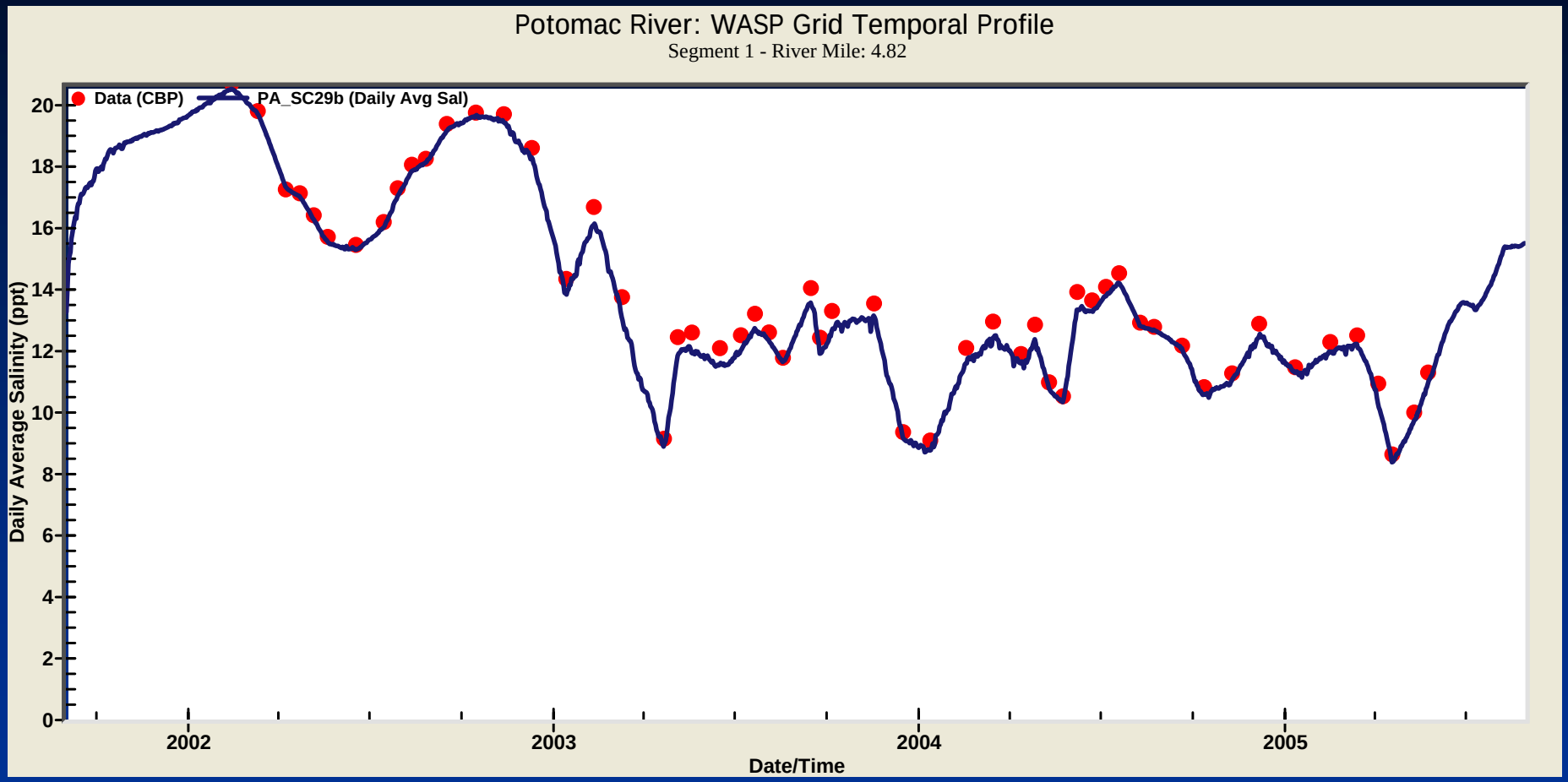


Moderate Flow – 10,428 cfs
(50th Percentile)



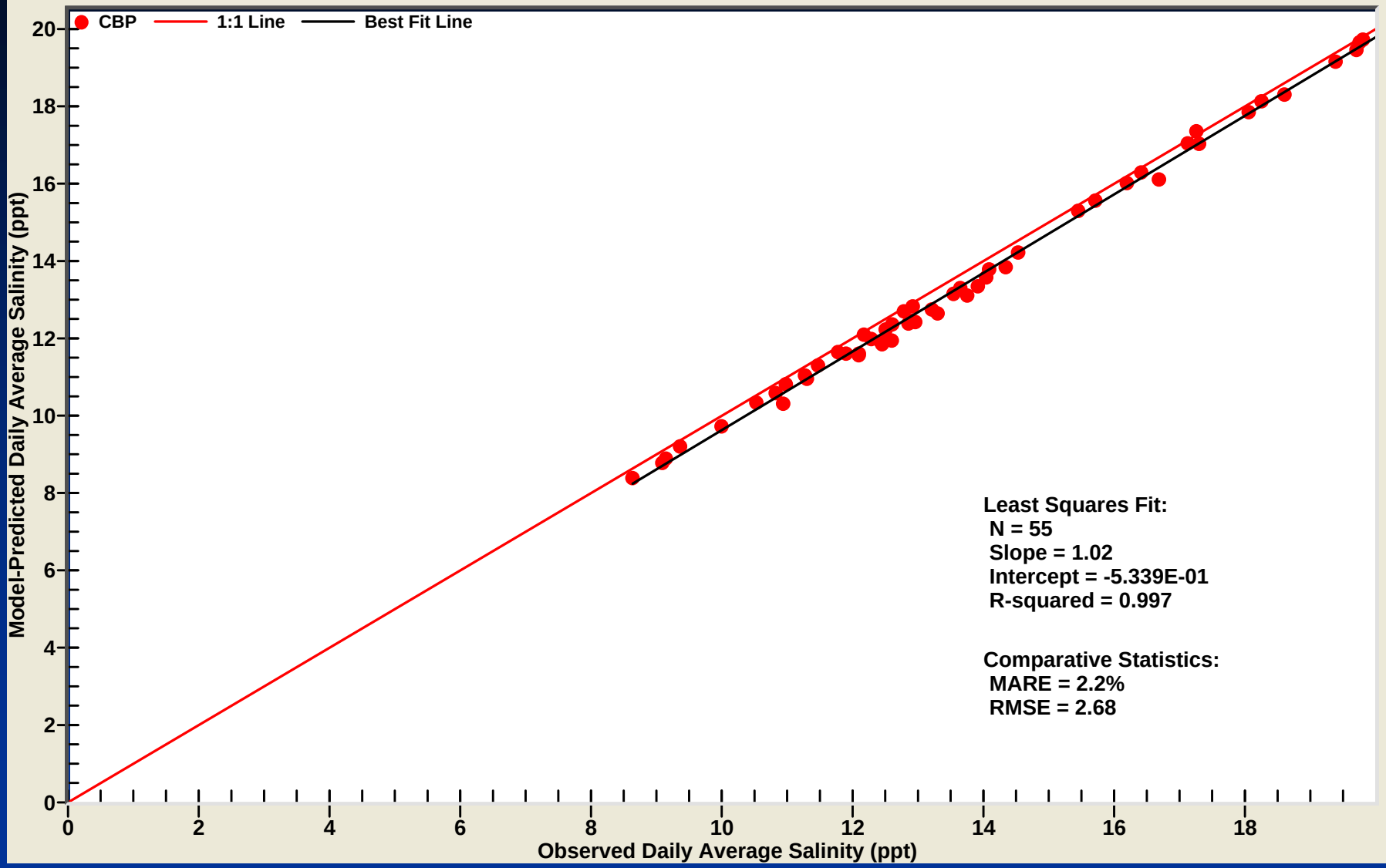
High Flow – 19,850 cfs
(80th Percentile)

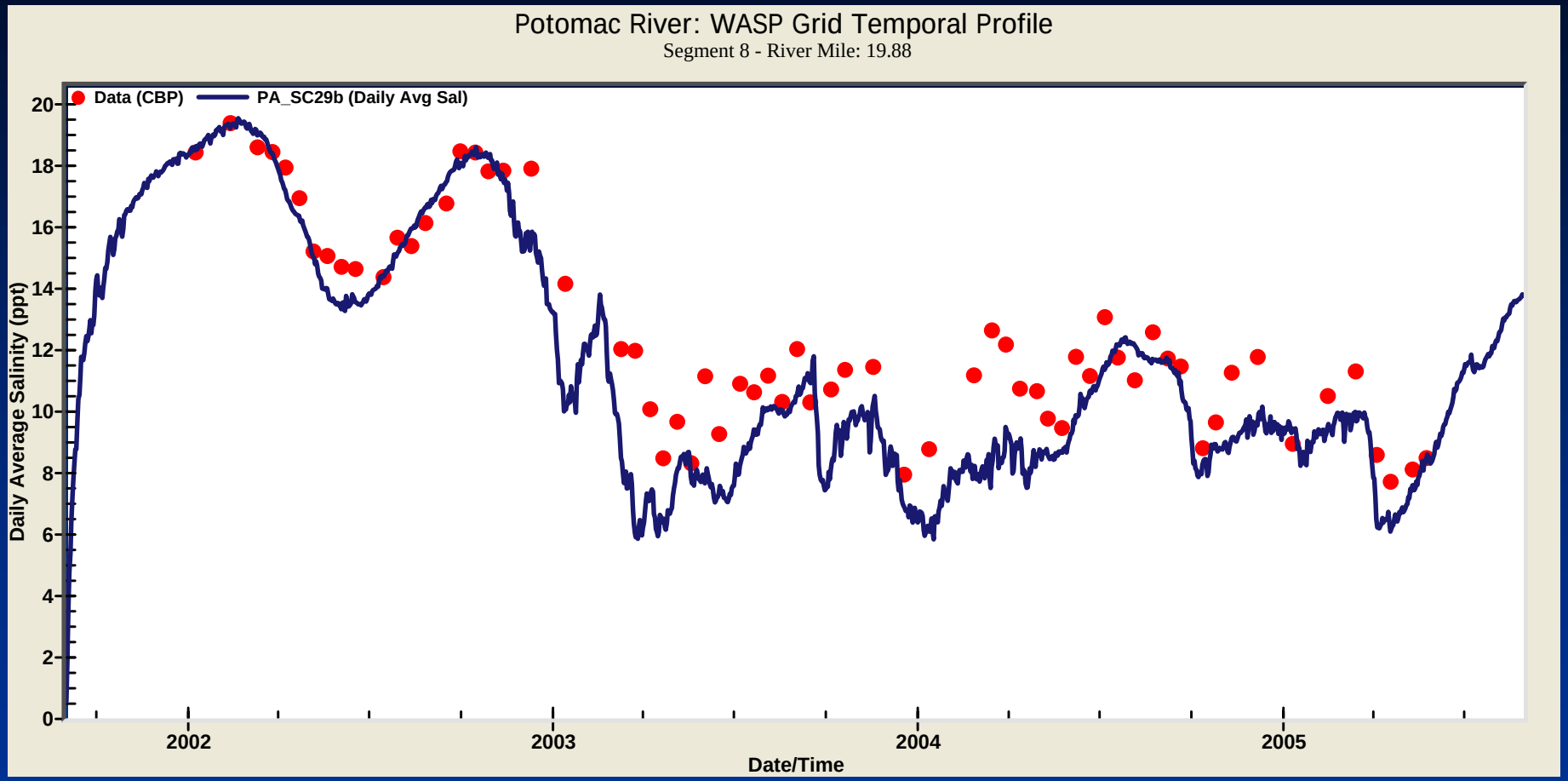



Potomac River: WASP Grid Temporal Profile
Segment 1 - River Mile: 4.82
Data (CBP)
PA_SC29b (Daily Avg Sal)
Daily Average Salinity (ppt)
0
2
4
6
8
10
12
14
16
18
20
2002
2003
2004
2005
Date/Time

Potomac River - Segment 1, River Mile 4.82

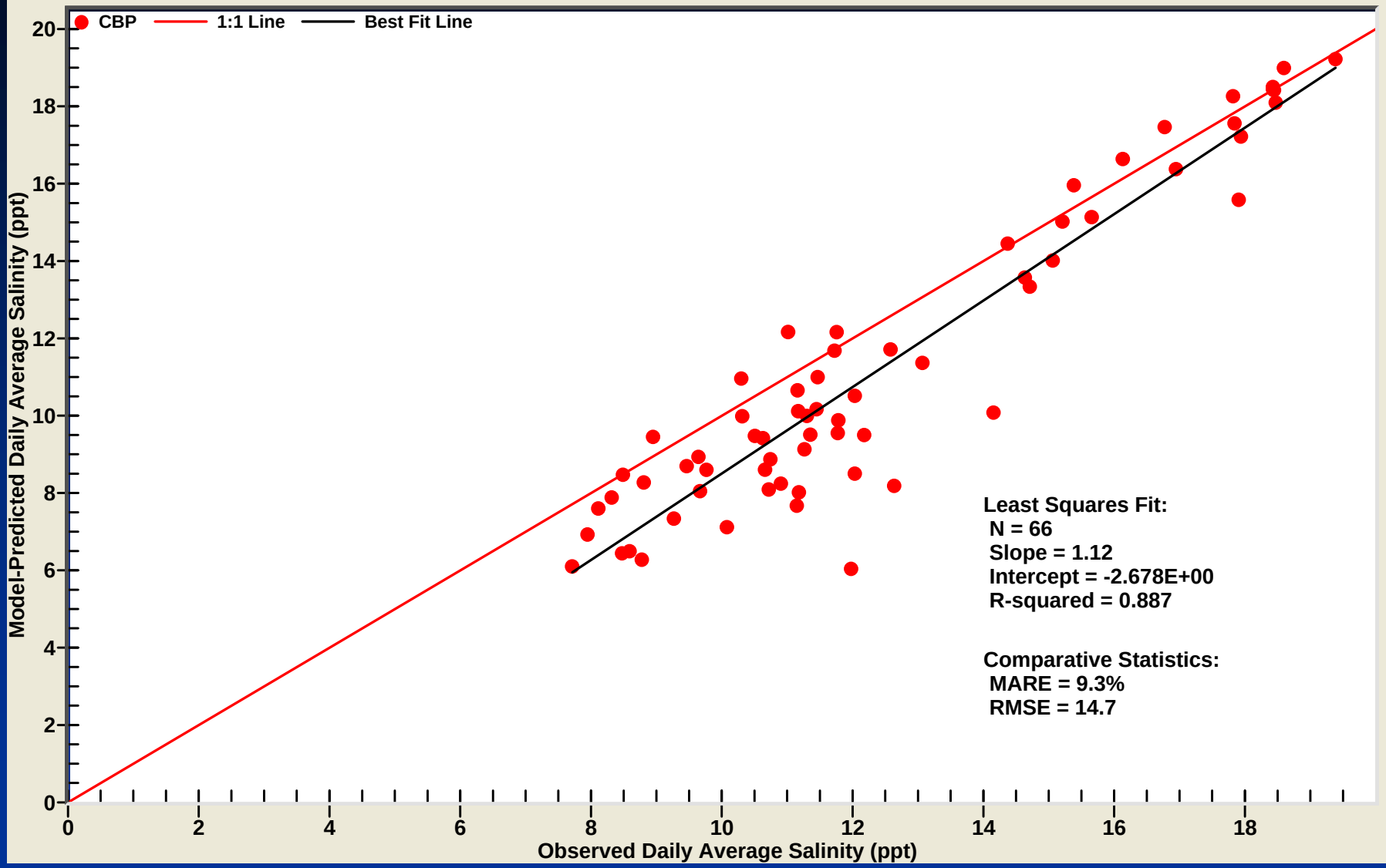
Model-Data Comparative Plot & Statistics

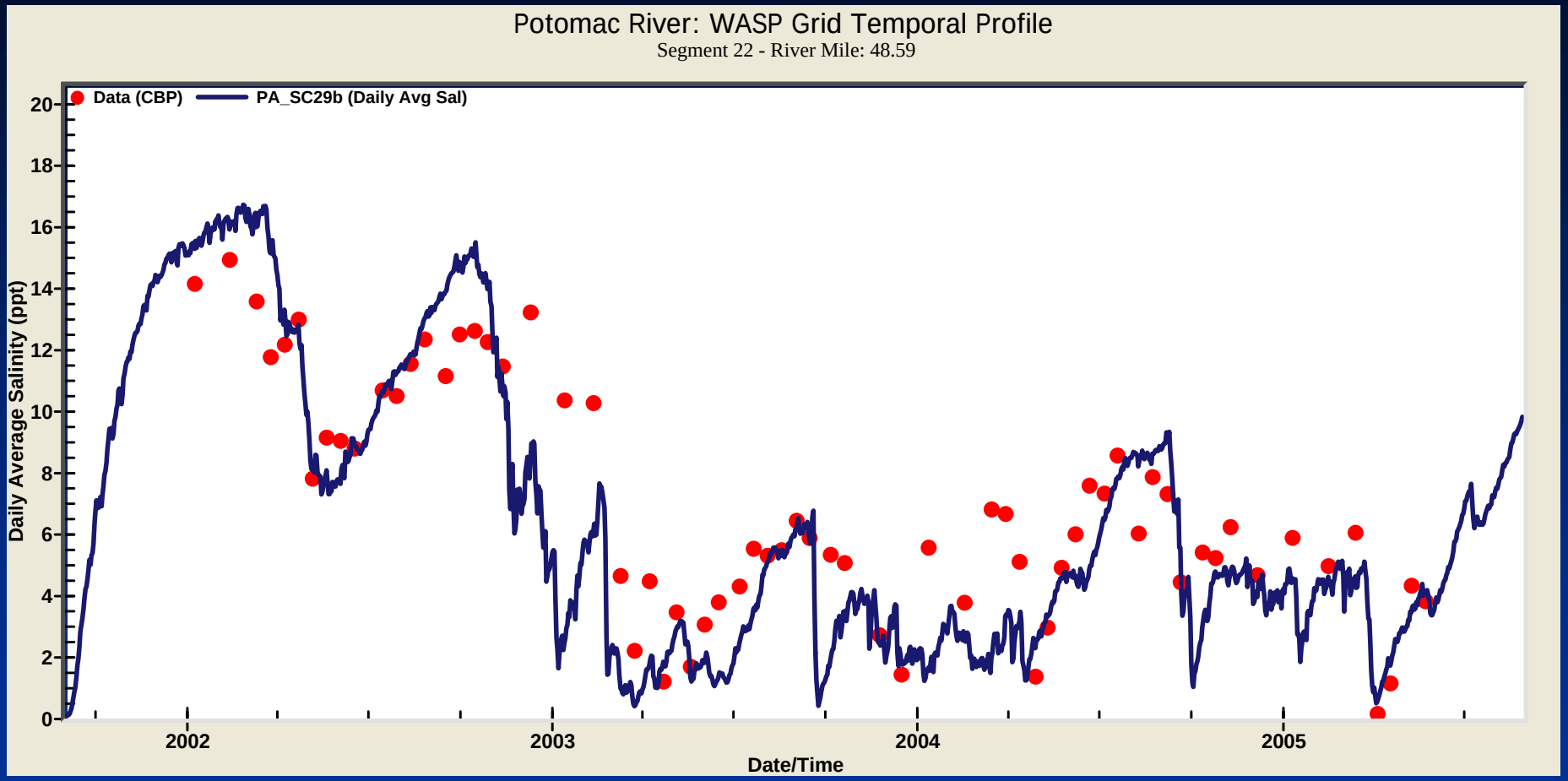



Potomac River: WASP Grid Temporal Profile
Segment 8 - River Mile: 19.88
Data (CBP)
PA_SC29b (Daily Avg Sal)
Daily Average Salinity (ppt)
0
2
4
6
8
10
12
14
16
18
20
2002
2003
2004
2005
Date/Time

Potomac River - Segment 8, River Mile 19.88

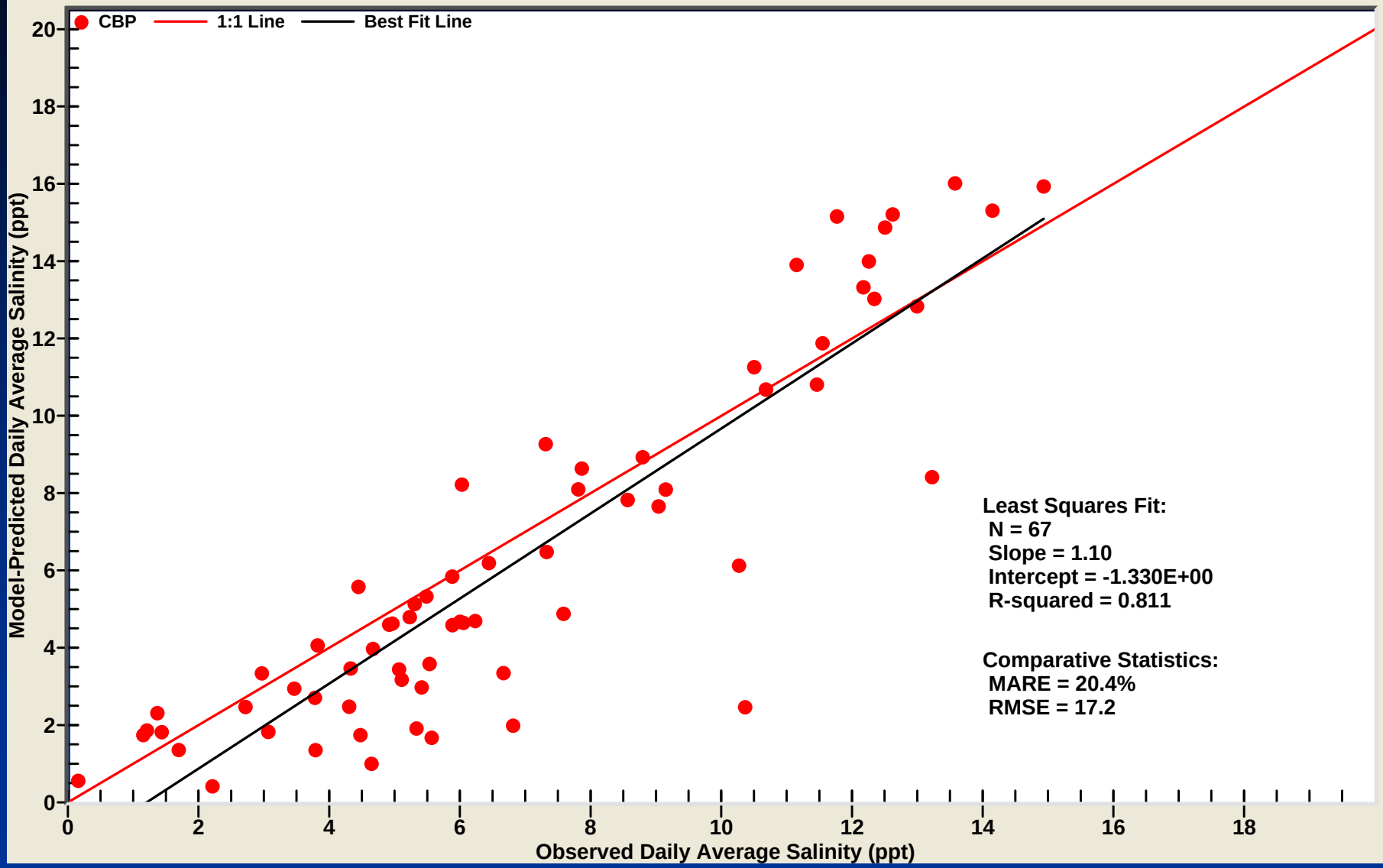
Model-Data Comparative Plot & Statistics

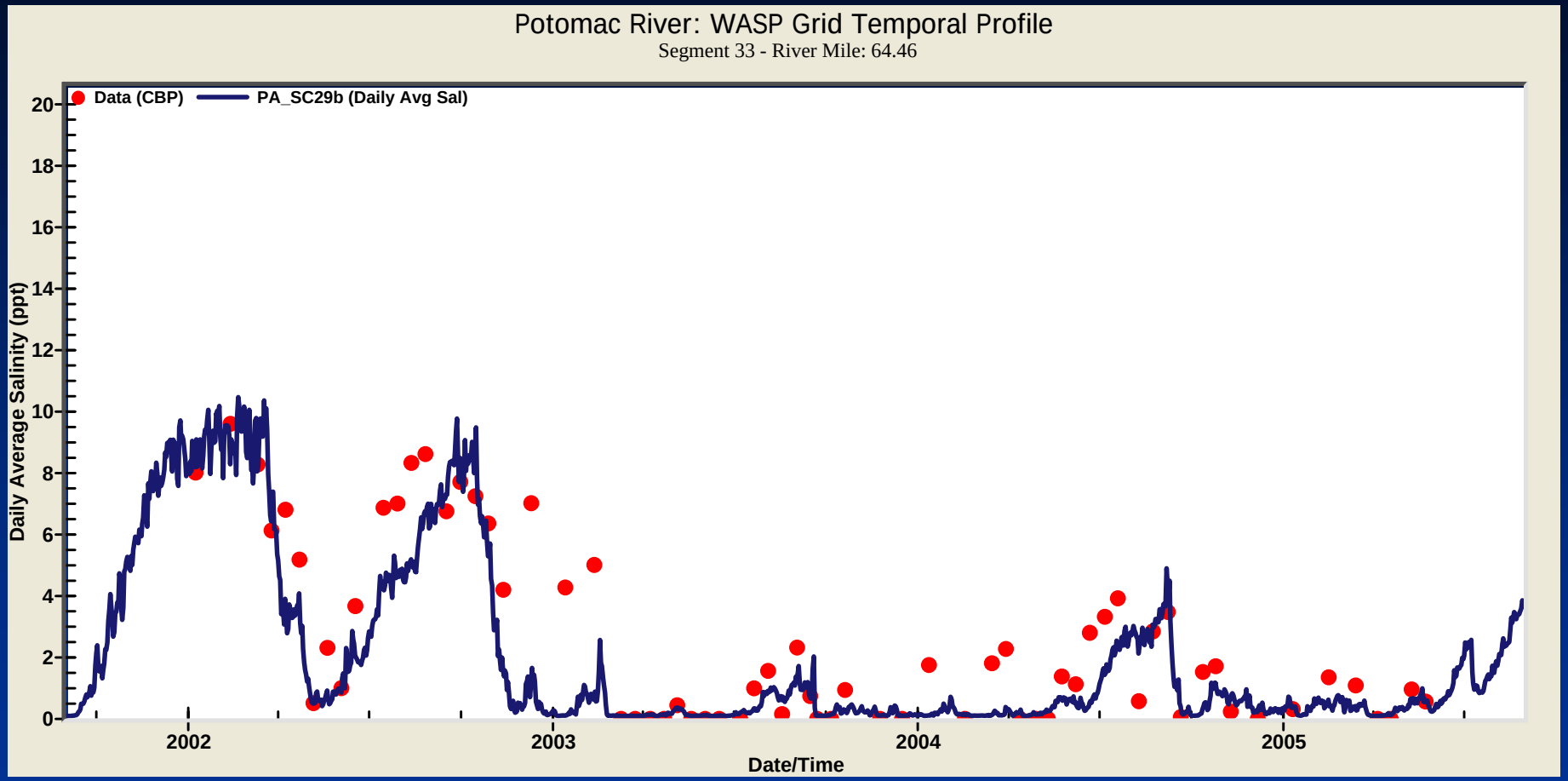



Potomac River: WASP Grid Temporal Profile
Segment 22 - River Mile: 48.59
Data (CBP)
PA_SC29b (Daily Avg Sal)
Daily Average Salinity (ppt)
0
2
4
6
8
10
12
14
16
18
20
2002
2003
2004
2005
Date/Time

Potomac River - Segment 22, River Mile 48.59

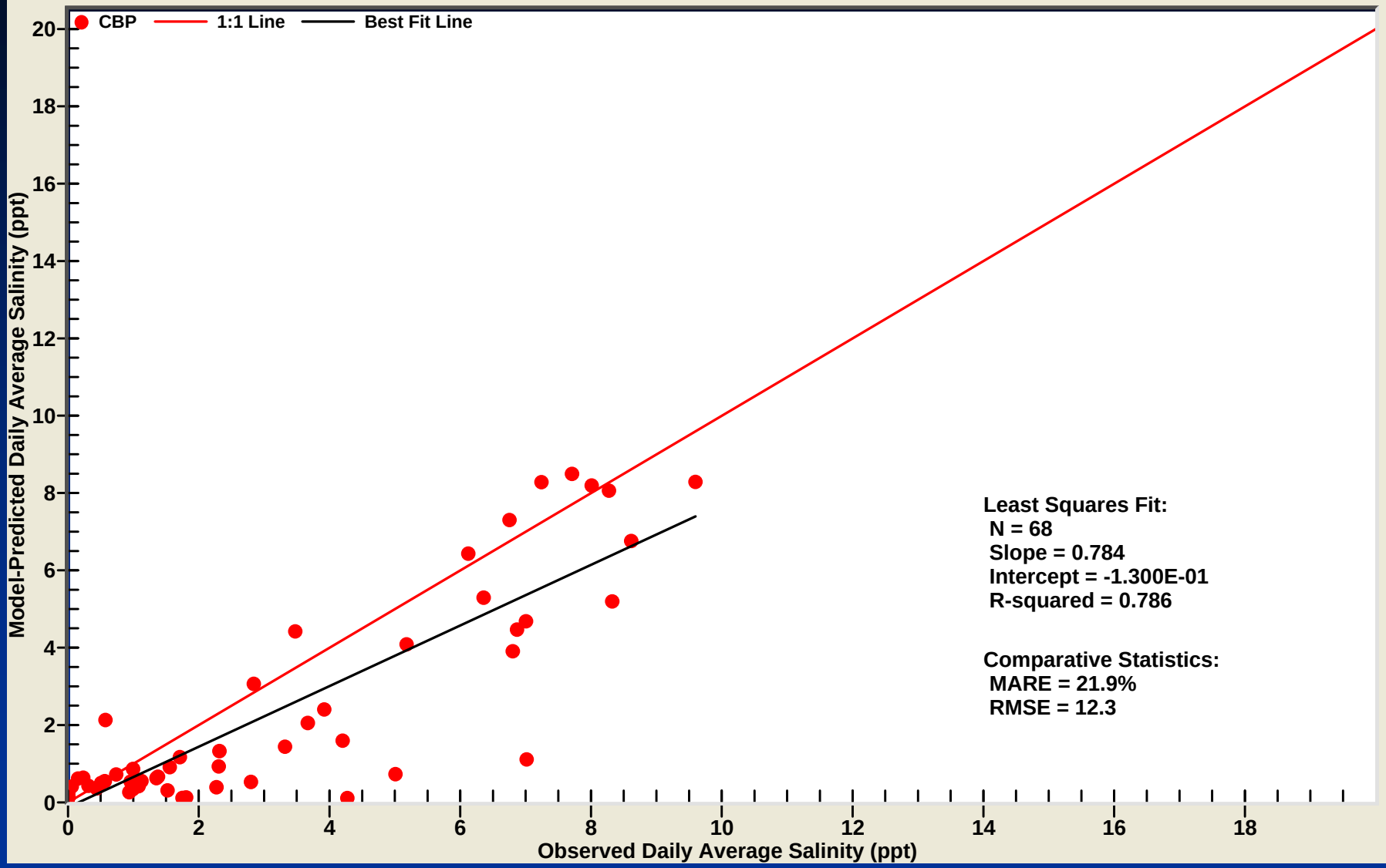
Model-Data Comparative Plot & Statistics

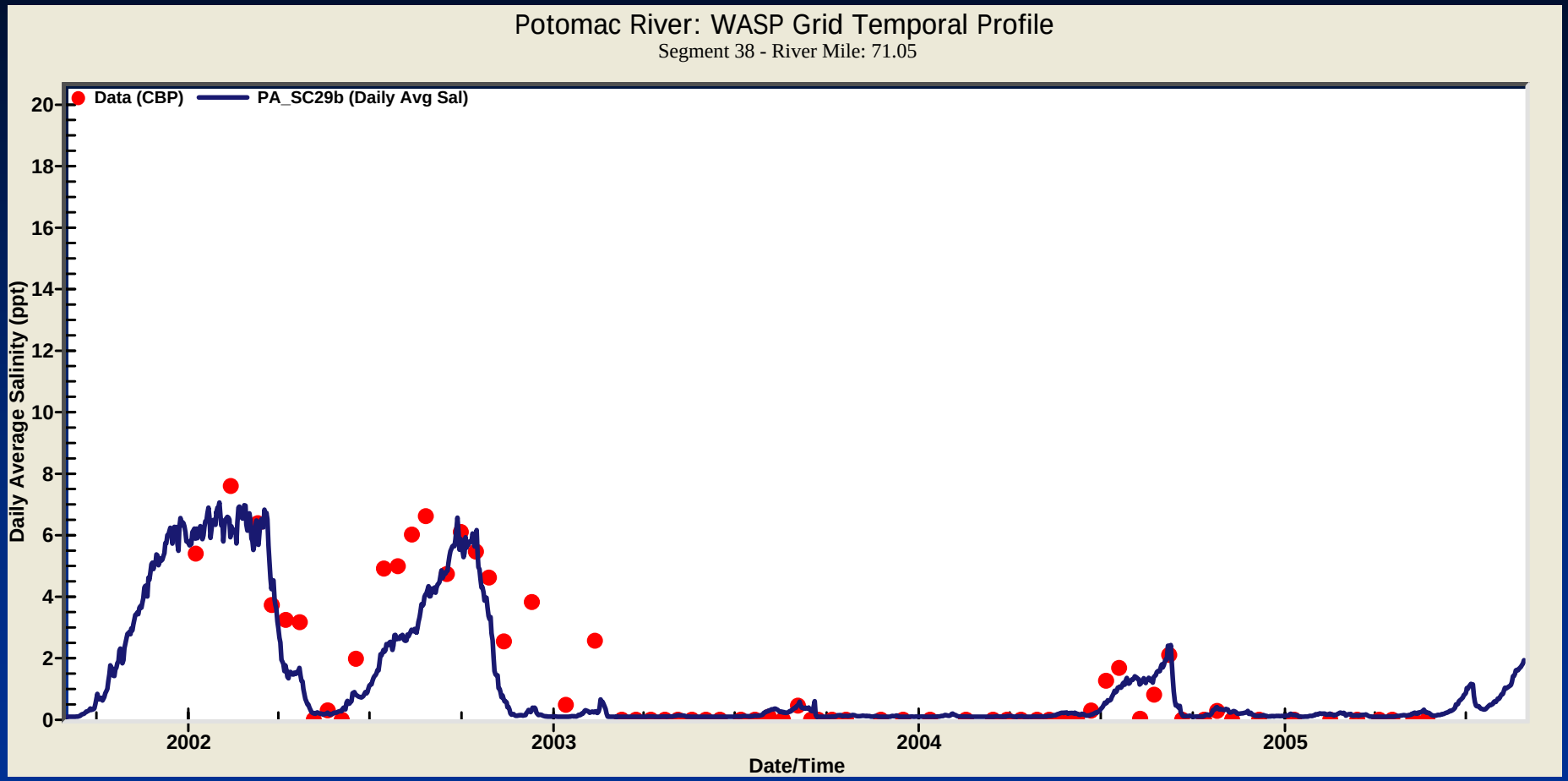



Potomac River: WASP Grid Temporal Profile
Segment 33 - River Mile: 64.46
Data (CBP)
PA_SC29b (Daily Avg Sal)
Daily Average Salinity (ppt)
0
2
4
6
8
10
12
14
16
18
20
2002
2003
2004
2005
Date/Time

Potomac River - Segment 33, River Mile 64.46

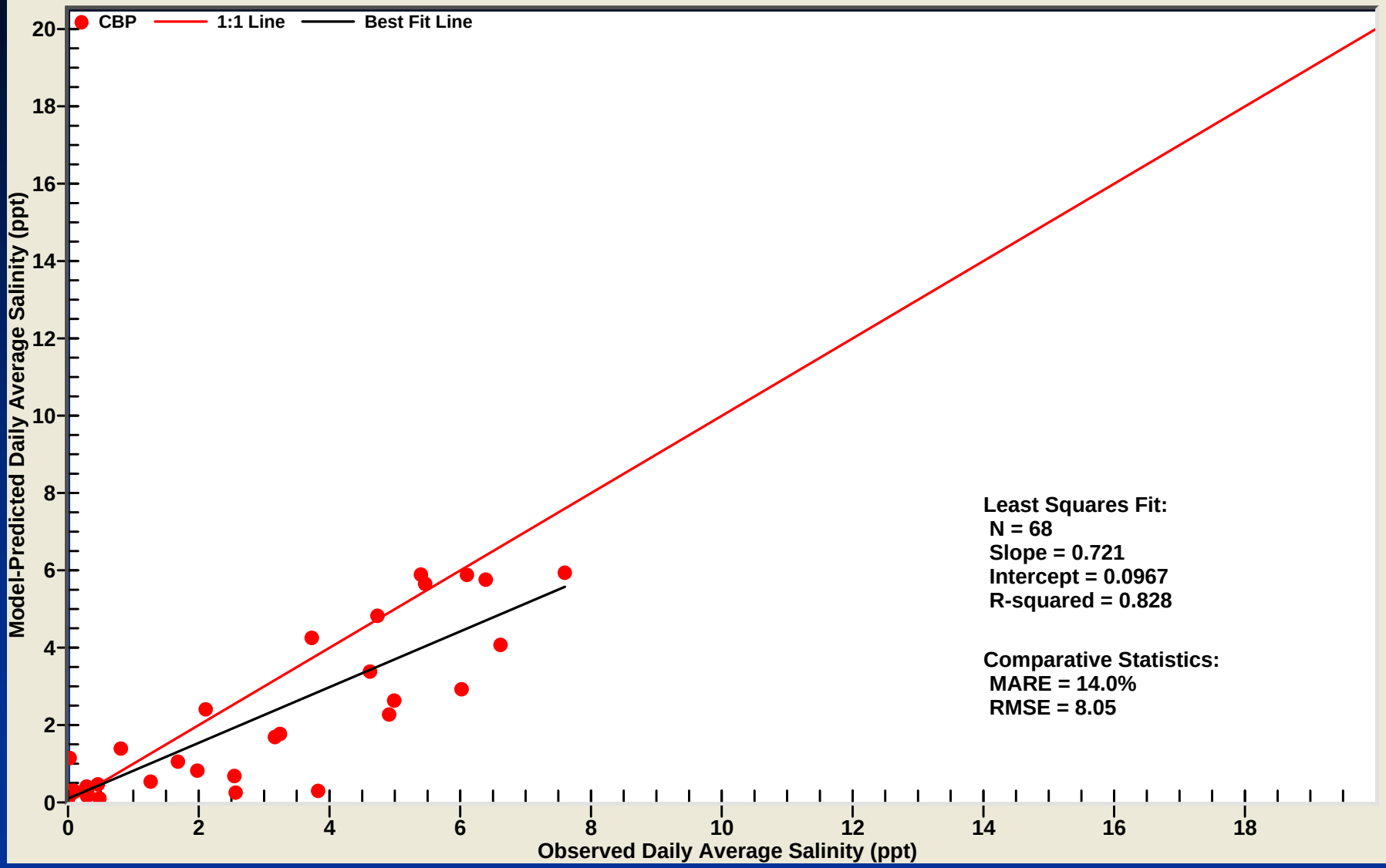
Model-Data Comparative Plot & Statistics

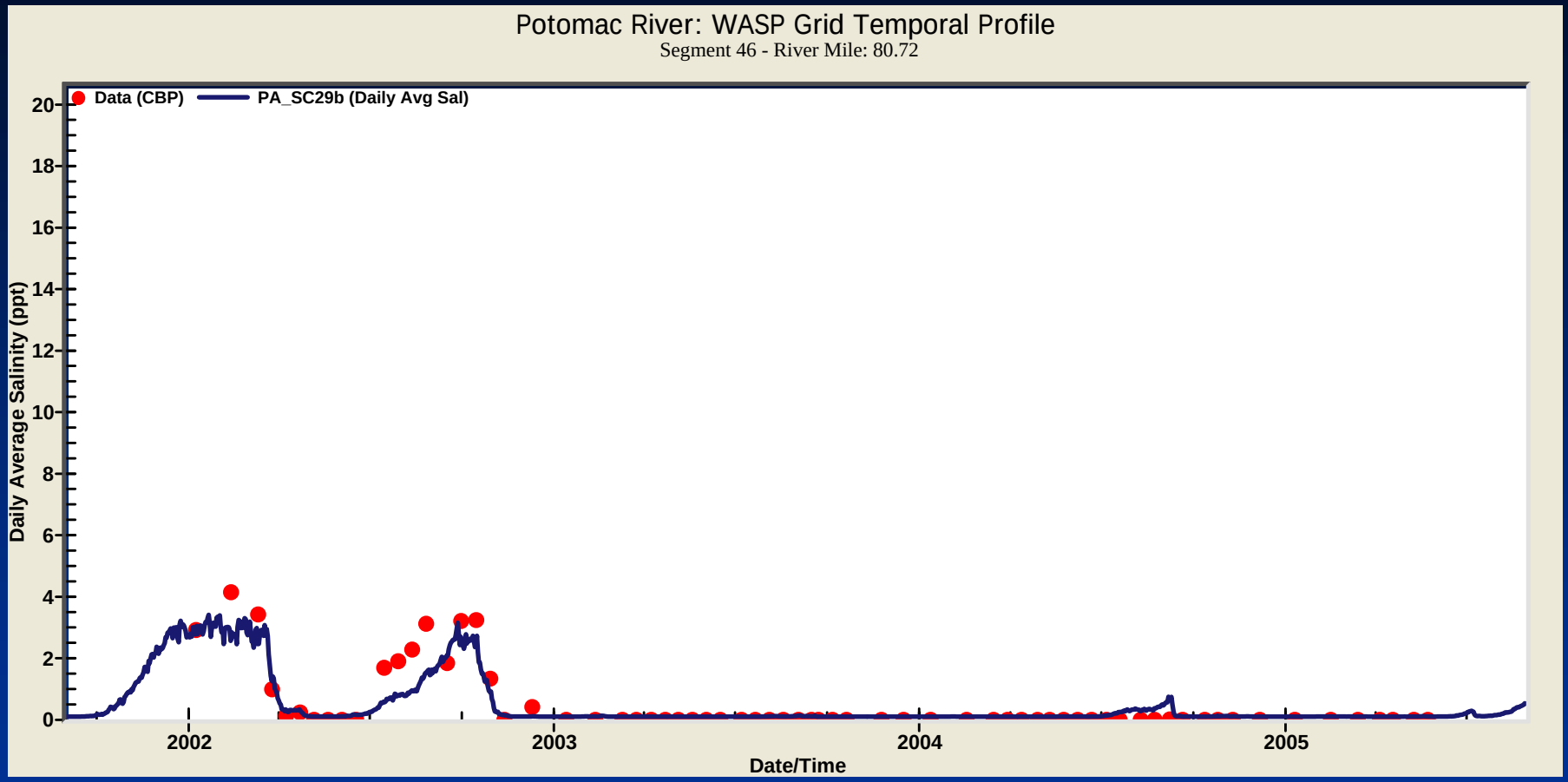



Potomac River: WASP Grid Temporal Profile
Segment 38 - River Mile: 71.05
Data (CBP)
PA_SC29b (Daily Avg Sal)
Daily Average Salinity (ppt)
0
2
4
6
8
10
12
14
16
18
20
2002
2003
2004
2005
Date/Time

Potomac River - Segment 38, River Mile 71.05

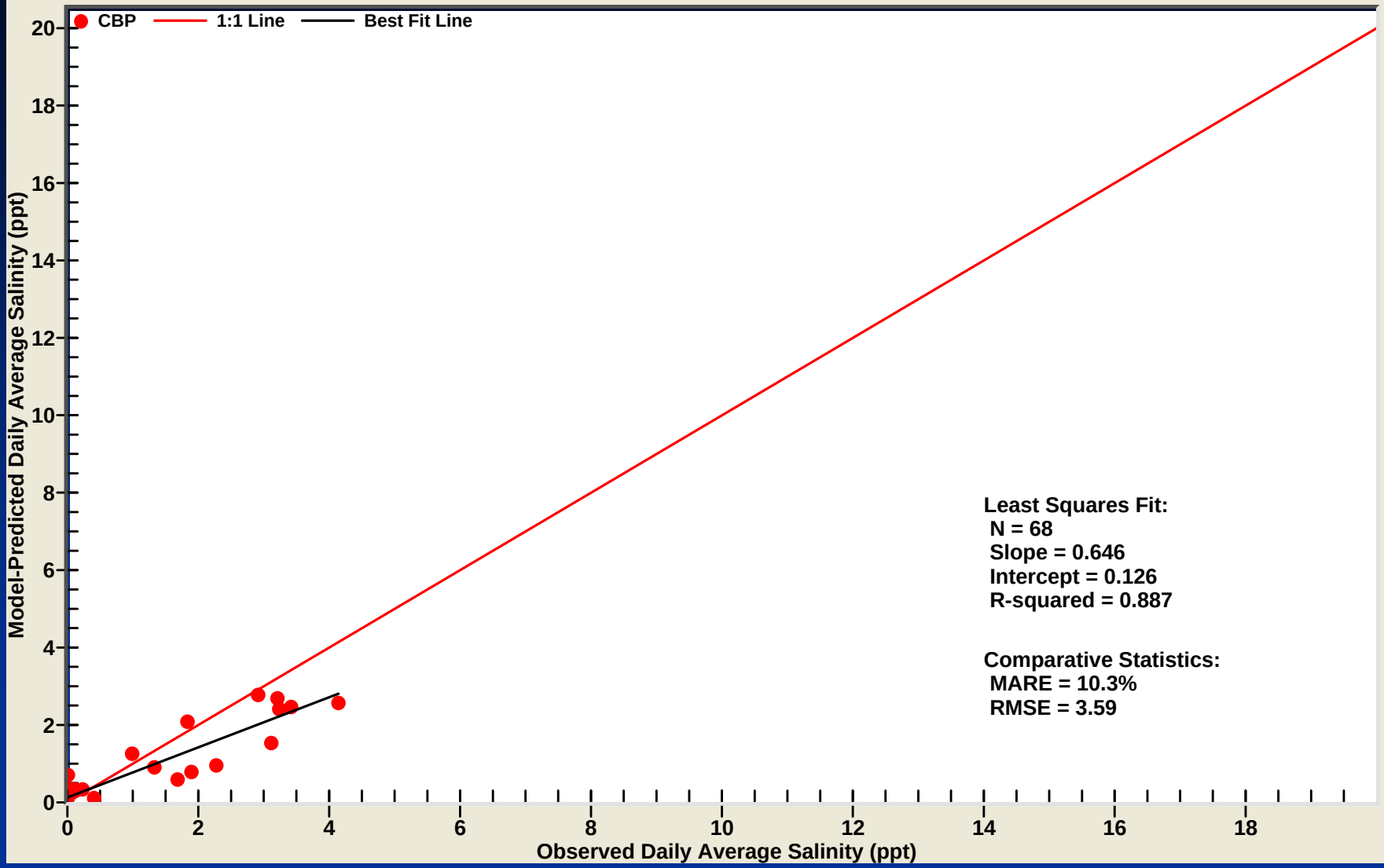
Model-Data Comparative Plot & Statistics

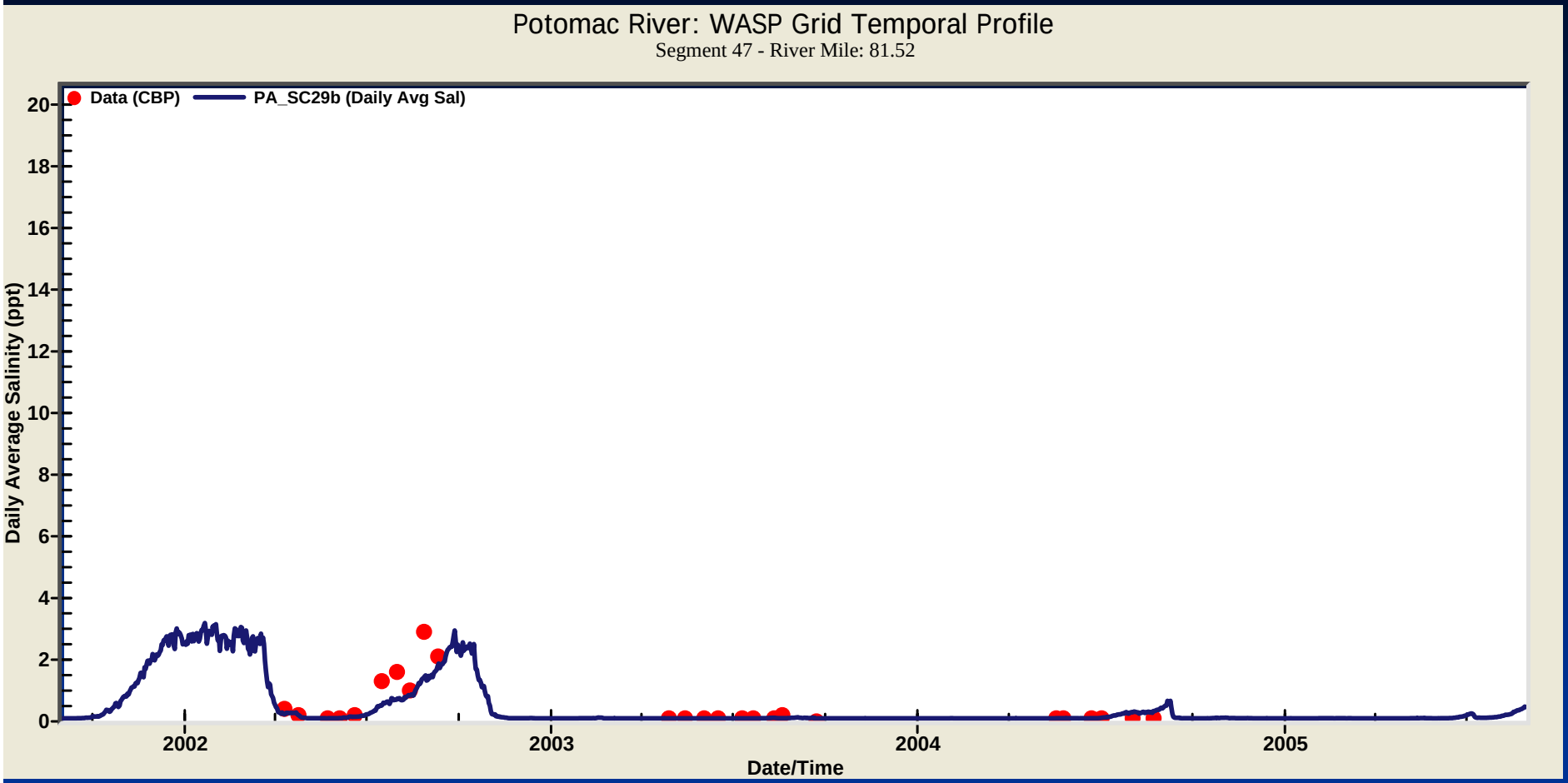



Potomac River: WASP Grid Temporal Profile
Segment 46 - River Mile: 80.72
Data (CBP)
PA_SC29b (Daily Avg Sal)
Daily Average Salinity (ppt)
0
2
4
6
8
10
12
14
16
18
20
2002
2003
2004
2005
Date/Time

Potomac River - Segment 46, River Mile 80.72

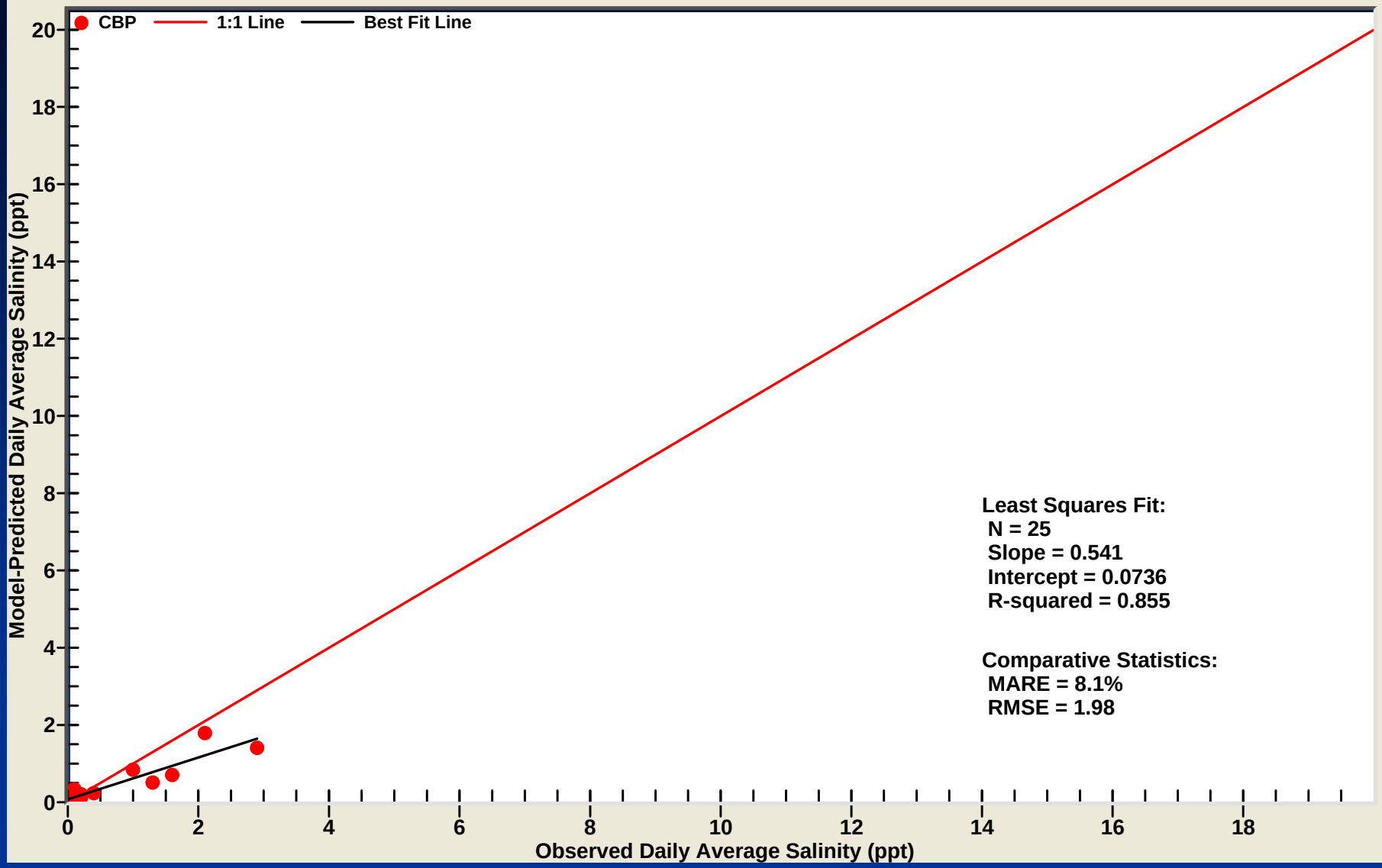
Model-Data Comparative Plot & Statistics

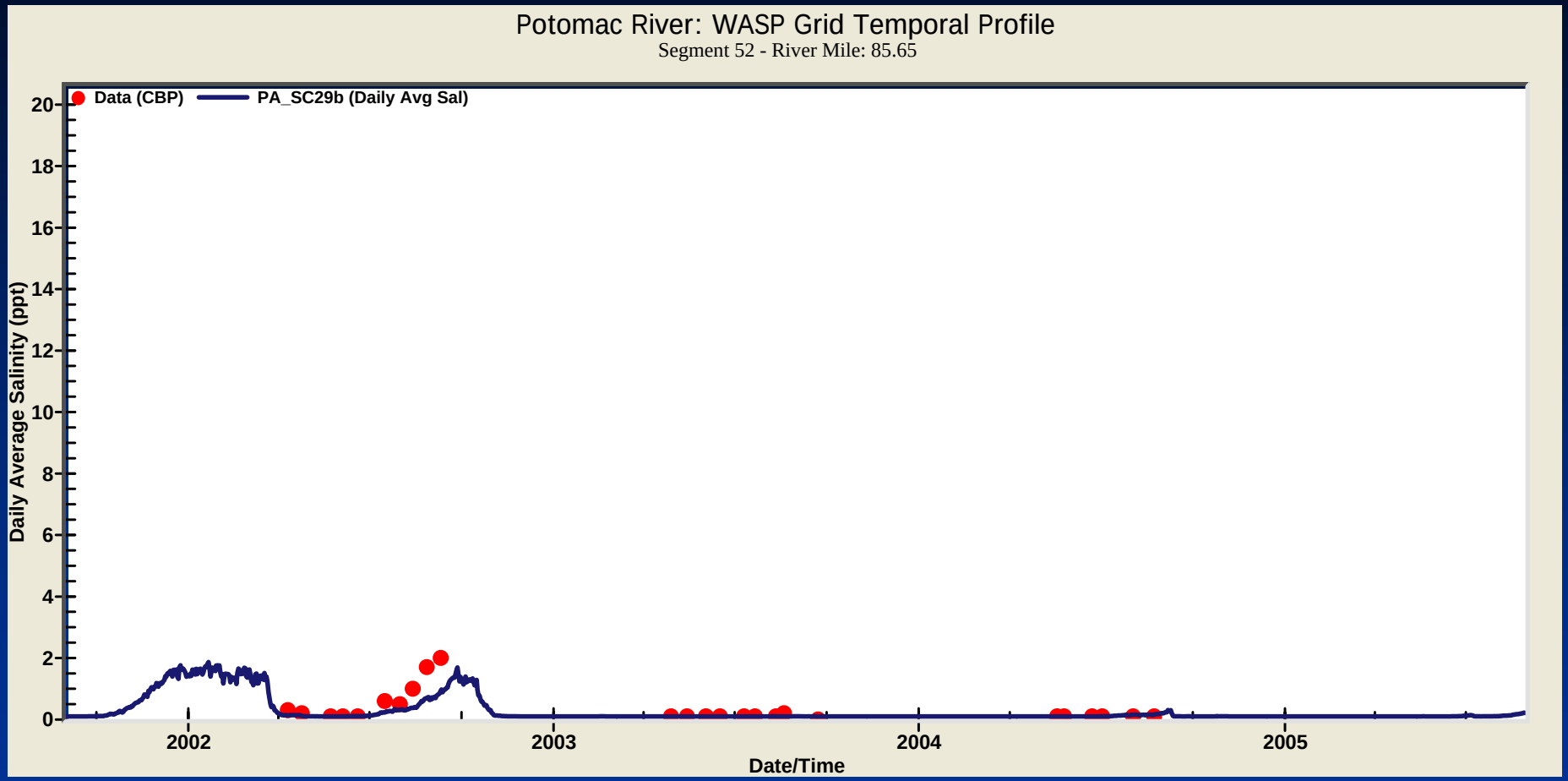



Potomac River: WASP Grid Temporal Profile
Segment 47 - River Mile: 81.52
Data (CBP)
PA_SC29b (Daily Avg Sal)
Daily Average Salinity (ppt)
0
2
4
6
8
10
12
14
16
18
20
2002
2003
2004
2005
Date/Time

Potomac River - Segment 47, River Mile 81.52

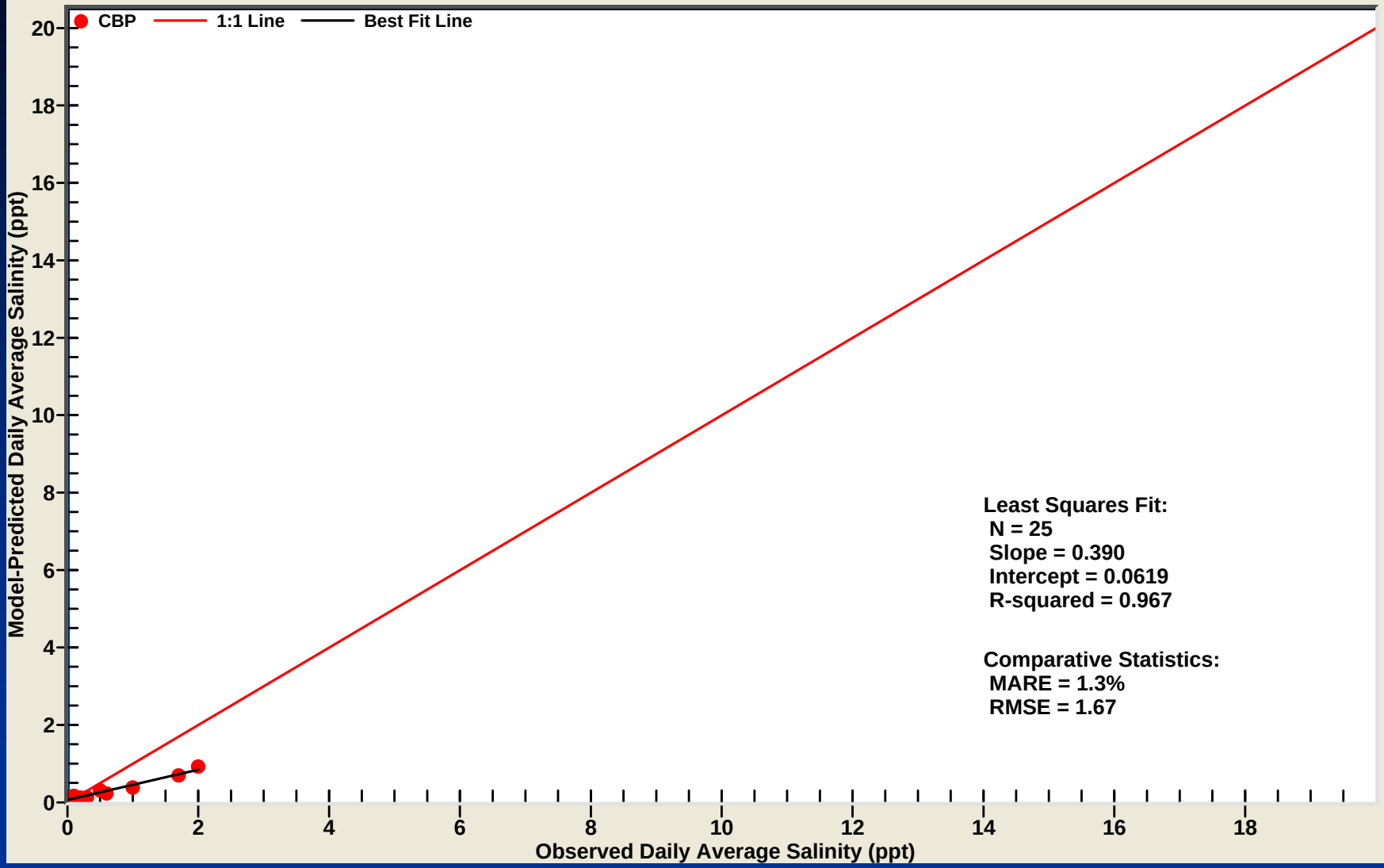
Model-Data Comparative Plot & Statistics

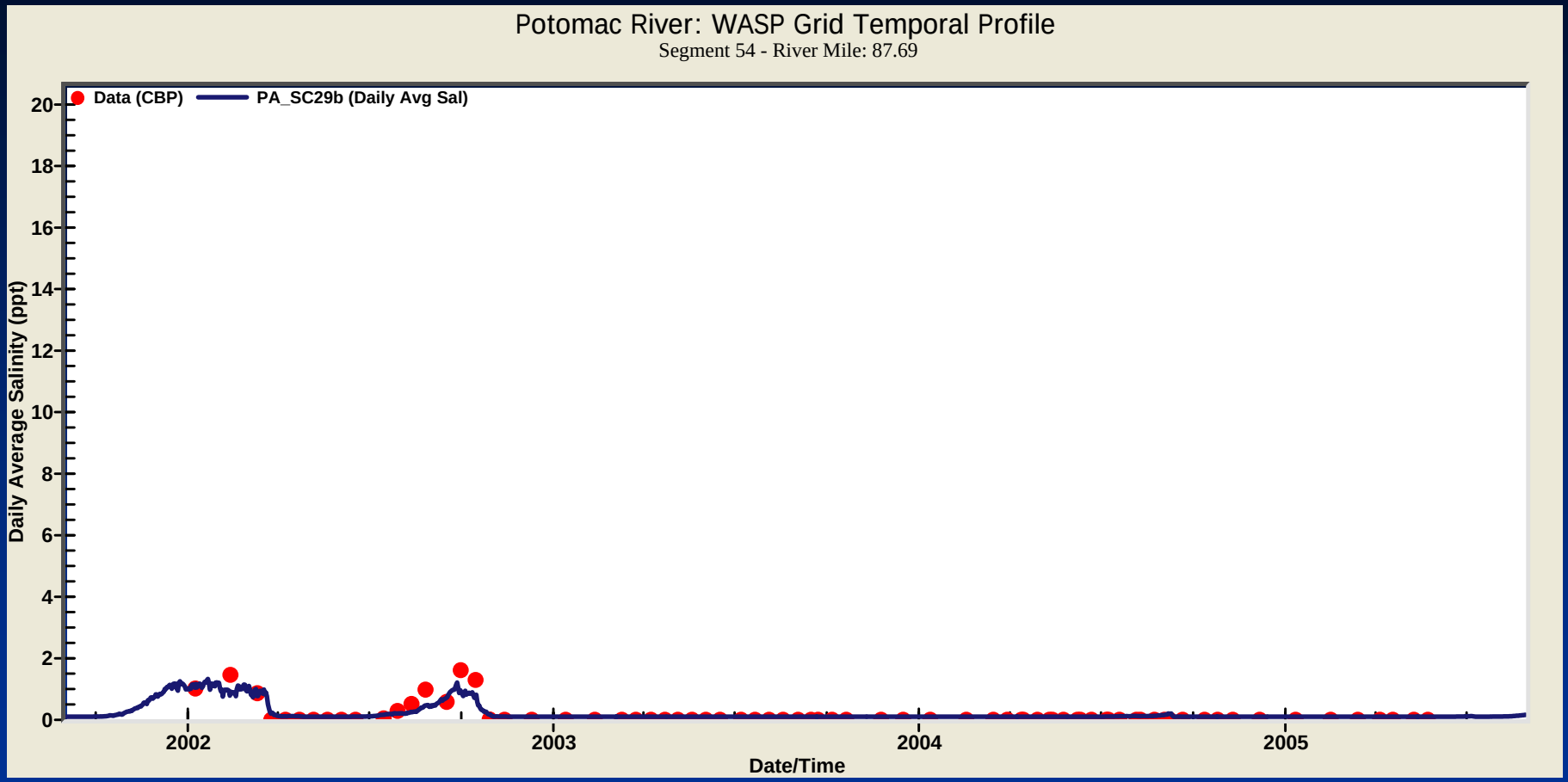



Potomac River: WASP Grid Temporal Profile
Segment 52 - River Mile: 85.65
Data (CBP)
PA_SC29b (Daily Avg Sal)
Daily Average Salinity (ppt)
0
2
4
6
8
10
12
14
16
18
20
2002
2003
2004
2005
Date/Time

Potomac River - Segment 52, River Mile 85.65

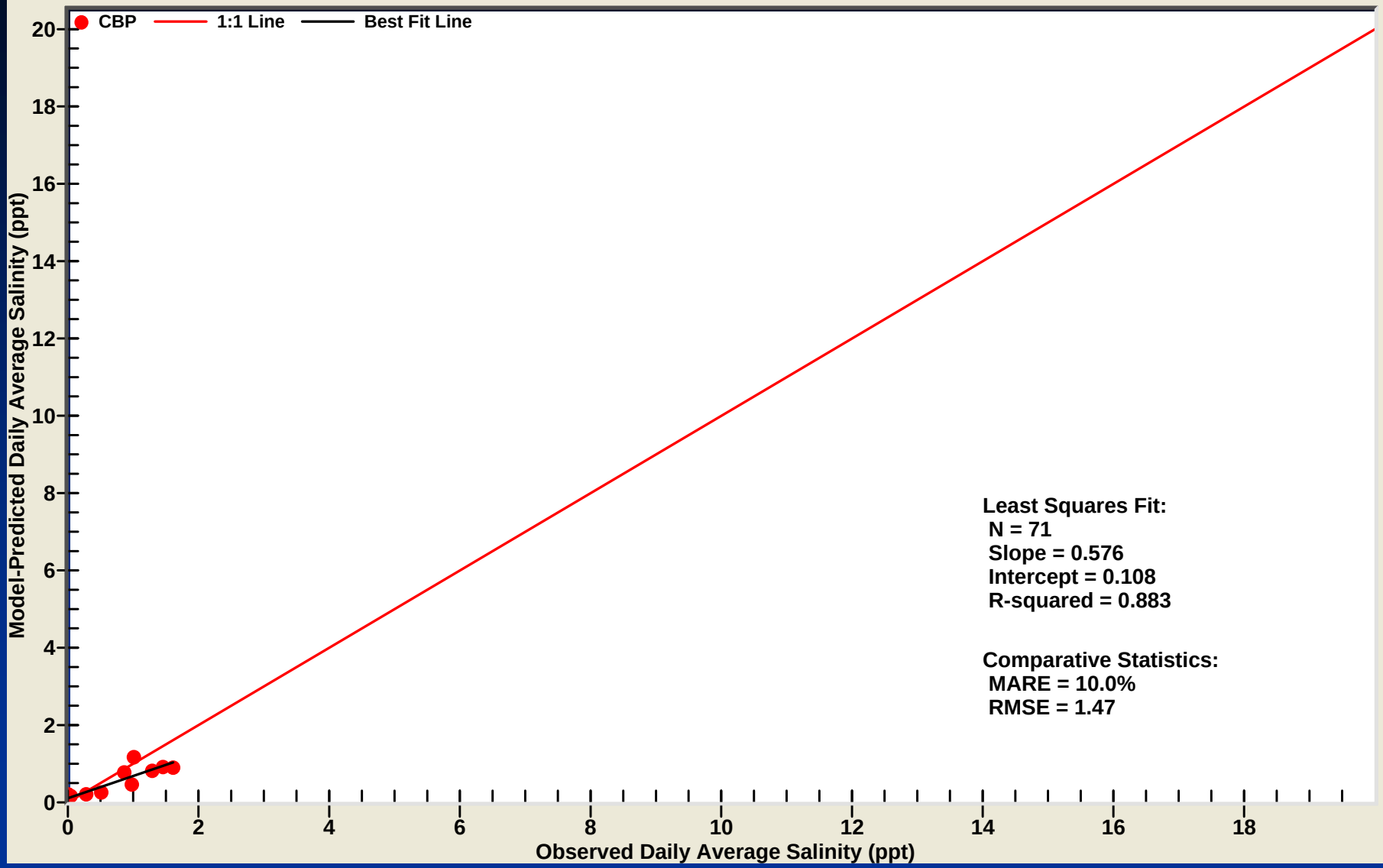
Model-Data Comparative Plot & Statistics

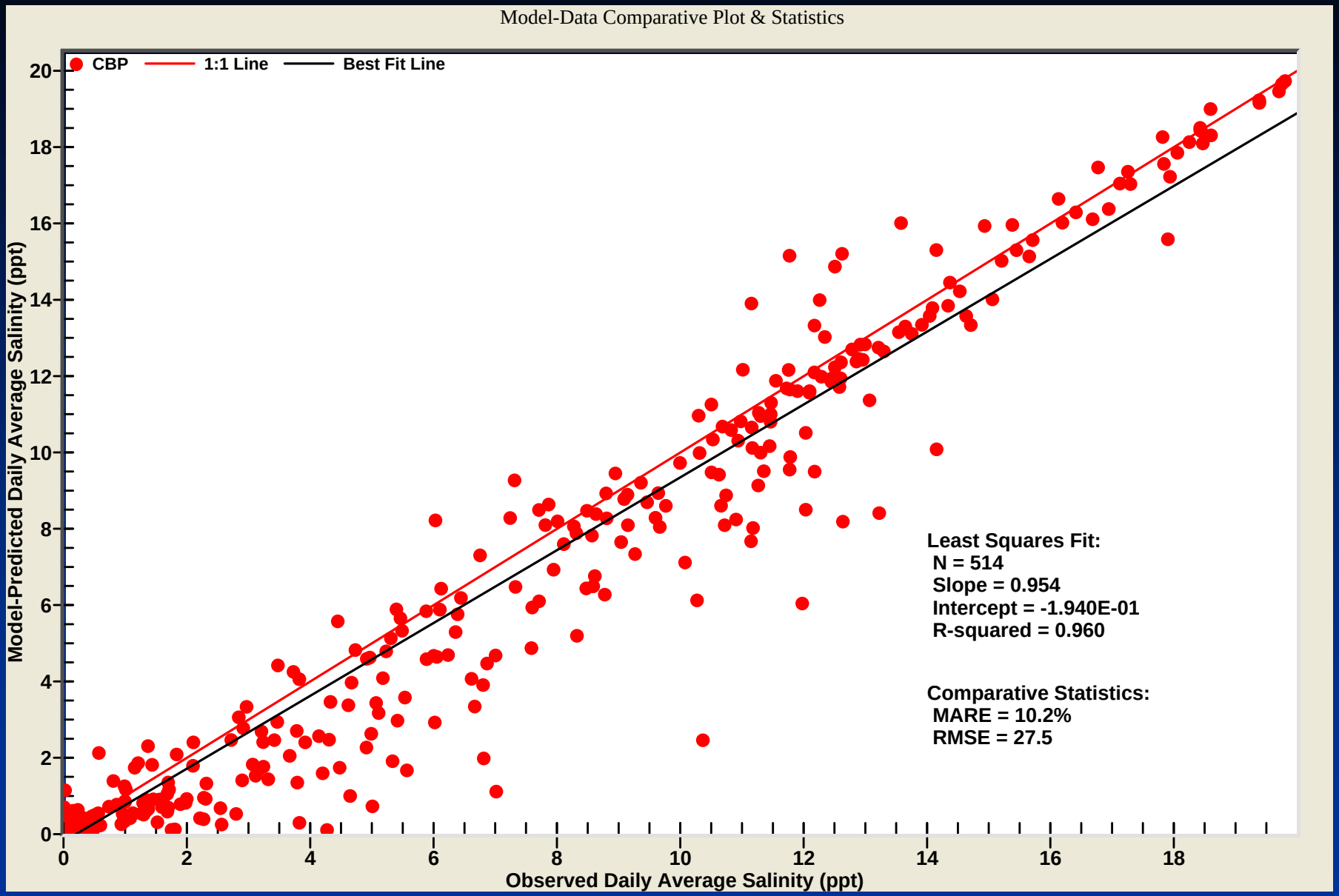


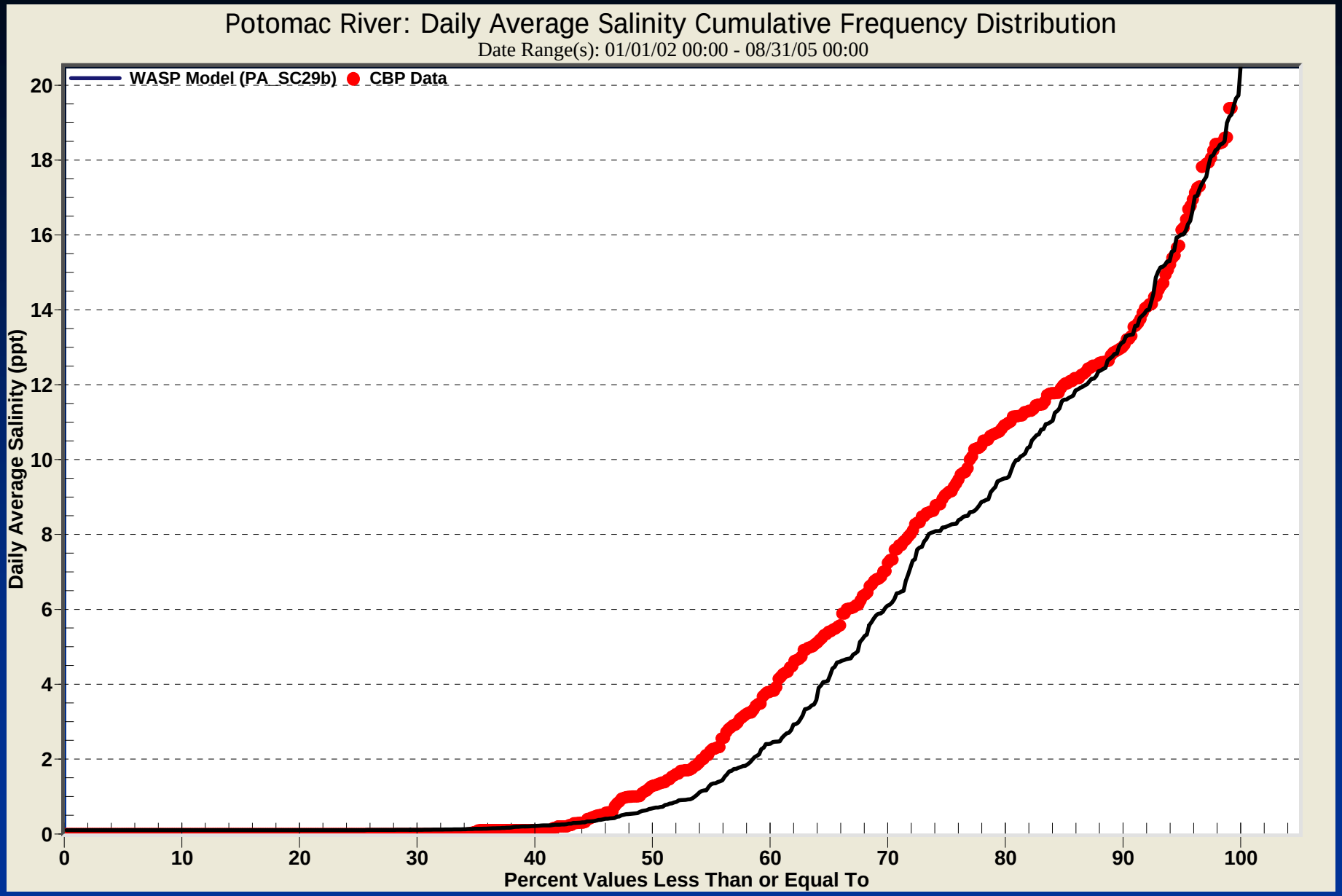

Potomac River: WASP Grid Temporal Profile
Segment 54 - River Mile: 87.69
Data (CBP)
PA_SC29b (Daily Avg Sal)
Daily Average Salinity (ppt)
0
2
4
6
8
10
12
14
16
18
20
2002
2003
2004
2005
Date/Time

Potomac River - Segment 54, River Mile 87.69

Model-Data Comparative Plot & Statistics

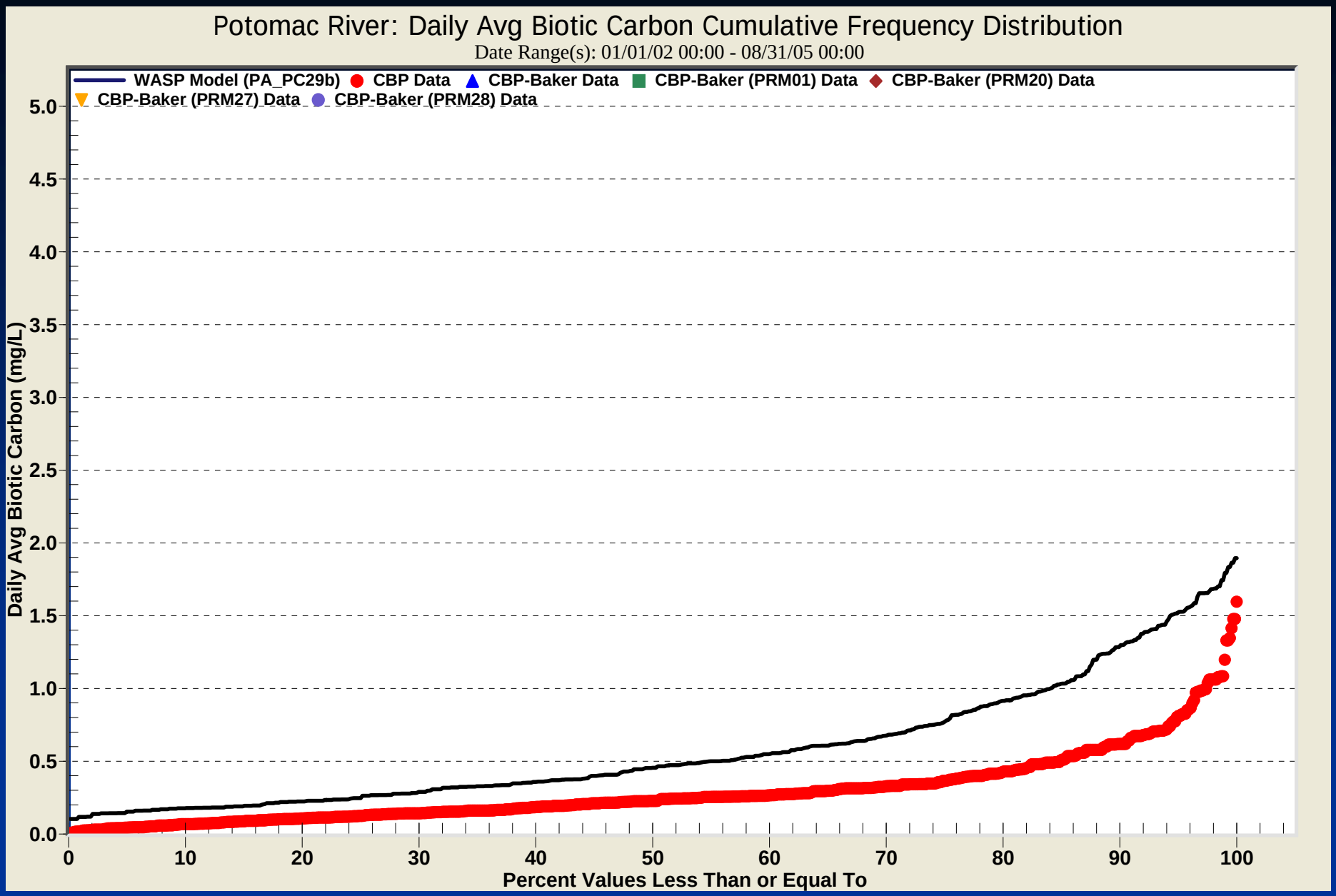


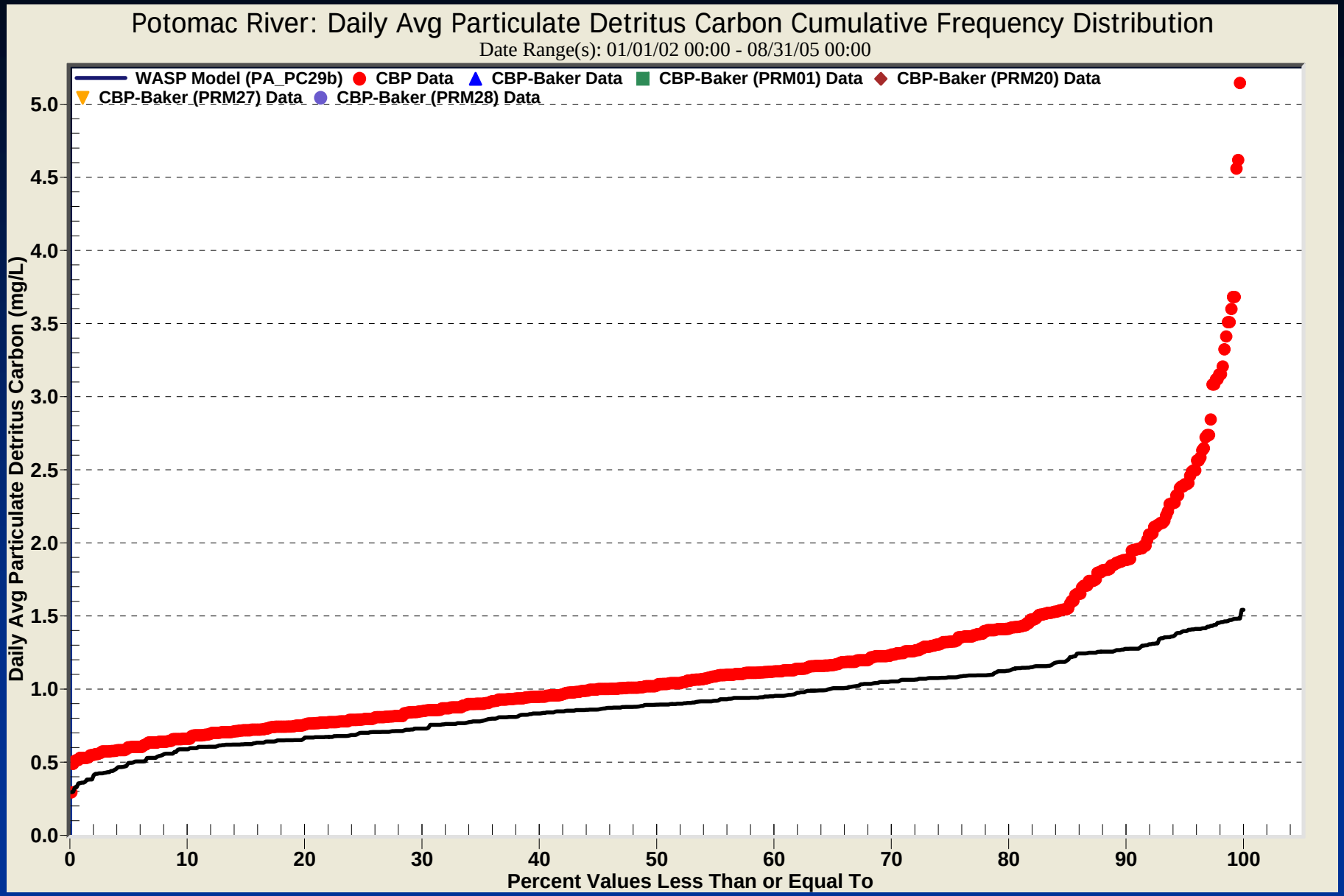

Model-Data Comparative Plot & Statistics
CBP
1:1 Line
Best Fit Line
Model-Predicted Daily Average Salinity (ppt)
Observed Daily Average Salinity (ppt)
0
2
4
6
8
10
12
14
16
18
20
Least Squares Fit:
N = 514
Slope = 0.954
Intercept = -1.940E-01
R-squared = 0.960
Comparative Statistics:
MARE = 10.2%
RMSE = 27.5


Potomac River: Daily Average Salinity Cumulative Frequency Distribution
Date Range(s): 01/01/02 00:00 - 08/31/05 00:00
WASP Model (PA_SC29b)
CBP Data
Daily Average Salinity (ppt)
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100
Percent Values Less Than or Equal To

Mass Balance Model

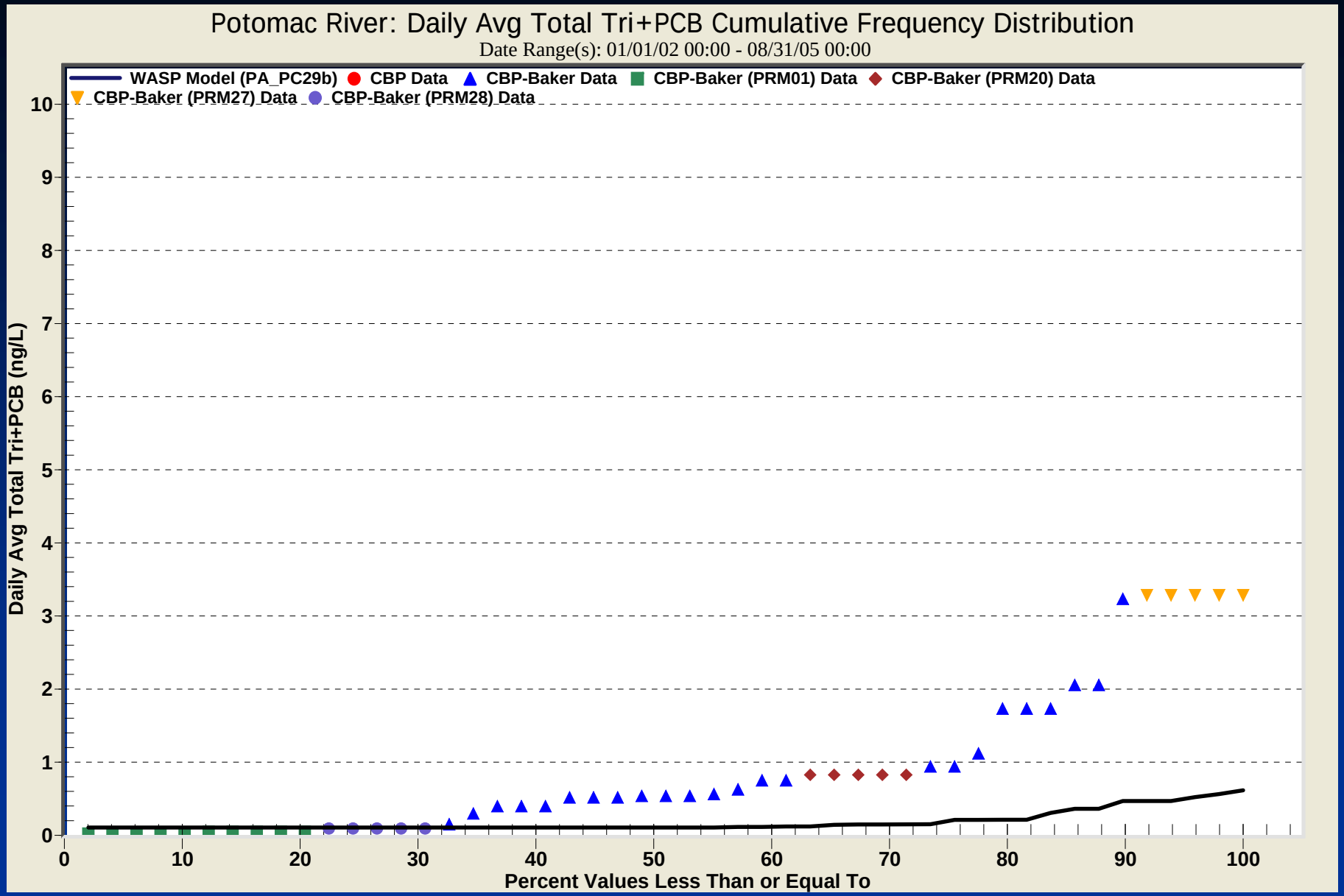
Organic Carbon Sorbents


Potomac River: Daily Avg Biotic Carbon Cumulative Frequency Distribution
Date Range(s): 01/01/02 00:00 - 08/31/05 00:00
WASP Model (PA_PC29b)
CBP Data
CBP-Baker Data
CBP-Baker (PRM01) Data
CBP-Baker (PRM20) Data
CBP-Baker (PRM27) Data
CBP-Baker (PRM28) Data
Daily Avg Biotic Carbon (mg/L)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
100
Percent Values Less Than or Equal To


Potomac River: Daily Avg Particulate Detritus Carbon Cumulative Frequency Distribution
Date Range(s): 01/01/02 00:00 - 08/31/05 00:00
WASP Model (PA_PC29b)
CBP Data
CBP-Baker Data
CBP-Baker (PRM01) Data
CBP-Baker (PRM20) Data
CBP-Baker (PRM27) Data
CBP-Baker (PRM28) Data
Daily Avg Particulate Detritus Carbon (mg/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
0
10
20
30
40
50
60
70
80
90
100
Percent Values Less Than or Equal To

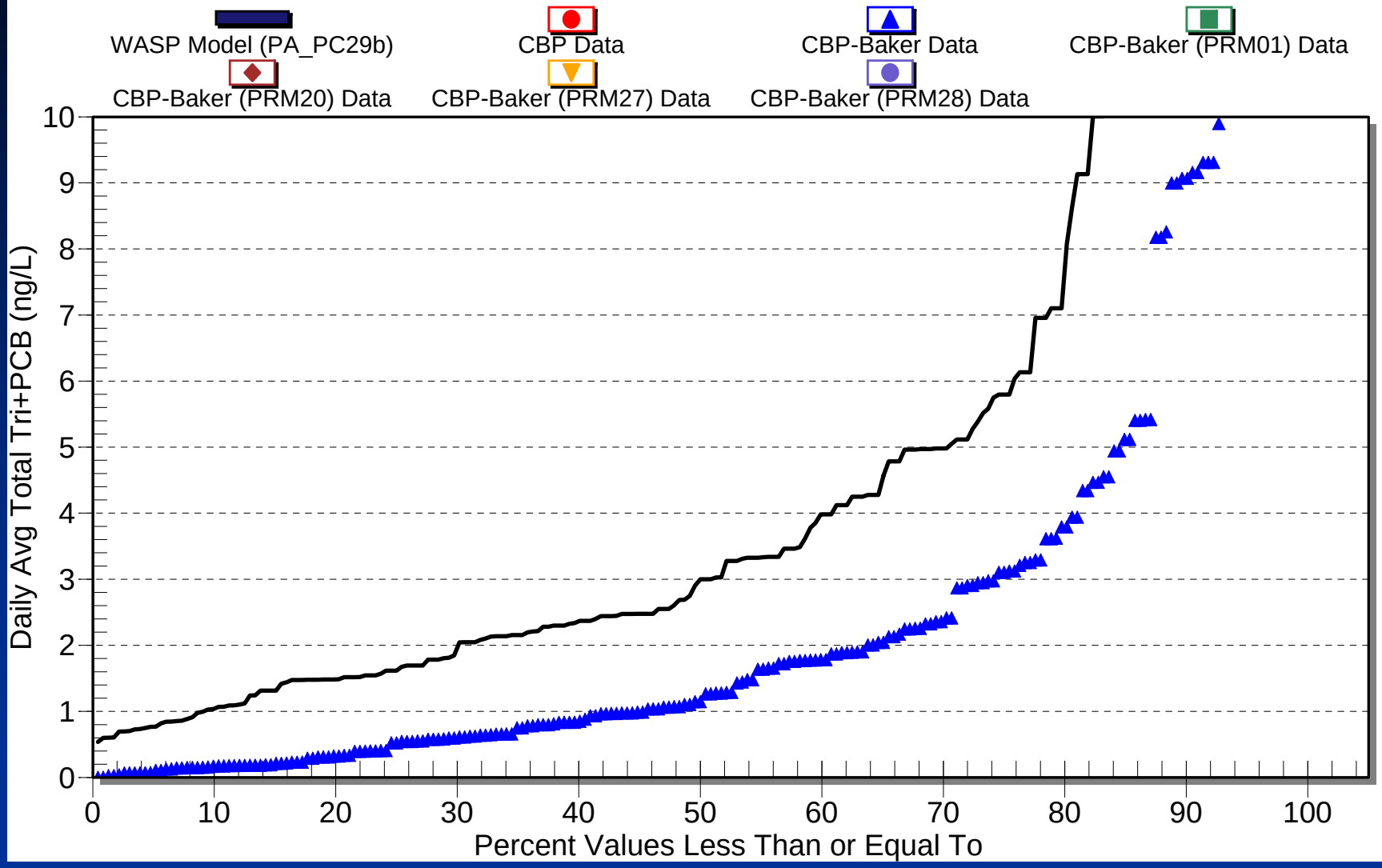
Mass Balance Model

Tri+ PCBs


Potomac River: Daily Avg Total Tri+PCB Cumulative Frequency Distribution
Date Range(s): 01/01/02 00:00 - 08/31/05 00:00
WASP Model (PA_PC29b)
CBP Data
CBP-Baker Data
CBP-Baker (PRM01) Data
CBP-Baker (PRM20) Data
CBP-Baker (PRM27) Data
CBP-Baker (PRM28) Data
Daily Avg Total Tri+PCB (ng/L)
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100
Percent Values Less Than or Equal To

Anacostia: Daily Avg Total Tri+PCB Cumulative Frequency Distribution

Date Range(s): 01/01/02 00:00 - 08/31/05 00:00



Next Steps in Modeling Effort

- Resolve outstanding loading issues
- Extend model through December 31, 2005
- Incorporate new WSM5 loads for organic carbon based on TSS and foc
- Incorporate solids (organic carbon) loads from bank erosion
- Implement capability for mass balance components analysis
- Analyze long-term PCB trends in fish and sediment
- Finalize model calibration for WSE, salinity, organic carbon and Tri+ PCBs
- Select 12-month cycling period for TMDL runs
- Translation of model results from Tri+ to Total PCBs
- Translation of model results to Total PCBs in fish tissue
- Use calibrated/validated model to develop PCB TMDL